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MANUAL OF INDUSTRIAL HYGIENE

AND
MEDICAL SERVICE IN WAR INDUSTRIES

*Issued under the Auspices of the Committee on
Industrial Medicine of the Division of Med-
ical Sciences of the National Research Council*

PREPARED BY THE DIVISION OF INDUSTRIAL
HYGIENE, NATIONAL INSTITUTE OF HEALTH,
UNITED STATES PUBLIC HEALTH SERVICE

WILLIAM M. GAFAFER, D.Sc.

Editor

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FOREWORD

THE urgent demand for doctors and engineers in the military forces has served to deplete industry's pool of experienced industrial physicians, industrial engineers, and industrial hygienists. This book is therefore intended not only as a source of information for industrial physicians who must meet the changed conditions in industries converted to war purposes, but as a guide for those who patriotically volunteer to take the places of industrial physicians who have gone into the service. I believe the book is sufficiently complete to accomplish these ends.

There are about 17 million workers in the war industries, and their number is steadily increasing. Consequently, they comprise a substantial section of the population, whose health is of immeasurable importance to the war effort. For the protection of their health and for the reduction of sickness absenteeism, which interferes so greatly with production, these workers depend upon an equally substantial proportion of the available civilian physicians of the United States.

It is hoped that this book will obtain a wide reading among all who have to deal in any way whatever with the health problems of war workers, and that it will arouse an awareness among them of the opportunities for usefulness in the production of war material.

In behalf of the Subcommittee on Industrial Health and Medicine, I wish to thank the Health and Medical Committee for making this important book possible; and also, Dr. James G. Townsend, Chief of Division of Industrial Hygiene, National Institute of Health, United States Public Health Service; the members of his staff; and the other contributors, for their excellent work.

C. D. SELBY, M.D., Chairman
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PREFACE

THE unprecedented growth of industry and the rapid development of industrial facilities to meet the needs of the Nation at war demand a corresponding increase in industrial health practice. This means the organization of programs and the adoption of policies which, in a large measure, should be uniform in structure.

Although the literature is abundant in its coverage for the many variables in medical and engineering industrial hygiene, there was not before available a book small enough to give compact knowledge and yet large enough to cover the entire subject. With this realization, the Committee on Industrial Medicine, Division of Medical Sciences, National Research Council, whose Chairman is Dr. Clarence D. Selby, recommended through the Health and Medical Committee that the Administrator of the Federal Security Agency instruct the Division of Industrial Hygiene, National Institute of Health, United States Public Health Service, through its Surgeon General, to prepare such a text. This we have done, with the knowledge that some may think too much emphasis has been given to certain subjects and not enough to others, and that still other items, important in the viewpoint of some authorities, have not been included. Due consideration has been given this, and much editing has been necessary to emphasize the *salient* points based on the Division's many years of experience in the industrial hygiene field, and yet keep the book within convenient size for reference.

Further detailed information may be obtained by writing to either this Division or, if one exists, to the industrial hygiene office of the State Government.

Finally, we should like to express our appreciation to those who reviewed a number of the chapters.

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PART I

ORGANIZATION AND OPERATION OF FACILITIES

CHAPTER 1

WAR'S INFLUENCE ON INDUSTRIAL HYGIENE

J. J. Bloomfield, B.S.Eng.

IN an address before the National Conference of Governmental Industrial Hygienists,¹ the Federal Security Administrator and Chairman of the Manpower Commission stated that the wartime task of industrial medicine was second in importance only to the responsibility of military medicine. That task, he said, is to keep every worker on the job by the prevention of sickness and accidents; and if disability is incurred, to restore the worker to the job "as quickly as science, skill and nature permit."

War, however, has brought about certain conditions which greatly complicate the problems of industrial health. Although specific difficulties are as varied as the enormously diversified war industries themselves, the national problem presents four broad conditions which exist, to a greater or less extent, in all of the 48 States and in the possessions. These are: first, health problems arising in the community environment; second, the physical composition of the war-labor force as compared to the peacetime labor supply; third, hazards which are found in the working environment; and fourth, the shortage of trained personnel in the various professions concerned with health conservation in industry.

THE COMMUNITY ENVIRONMENT AND THE WORKER

The industrial hygienist is well aware that his efforts to ensure a safe and healthful working environment are often nullified by unfavorable conditions in the community. The rapid expansion of war industries has had an incalculable effect upon the provision of adequate community service in many parts of the country. For example, the war contracts allotted to date have been very unevenly distributed geographically. At one time, 73

per cent of the war contracts were allotted in 20 industrial centers containing 22 per cent of the total population. As a result of war production, there is in motion a vast transmigration of workers and their families. New war plants have been built in rural areas with little thought to the provision of even rudimentary facilities such as adequate housing, safe water, and sewage disposal.

Under the "Community Facilities Act," Congress has appropriated some \$300,000,000 for the construction of schools, hospitals, water supply, sewage disposal, and other public works in war areas. This sum was about \$50,000,000 short of the estimated cost of essential construction at the time of the attack on Pearl Harbor. Construction, however, has been hampered owing to the difficulty of obtaining critical materials.

With the crowding in factories, crowding in homes, crowding in transportation facilities, war industries are under constant threat of outbreaks of contagious disease among employees, which would seriously disrupt production. Every necessary precaution must be taken to avoid such an occurrence. The strengthening of general public health services in the community thus becomes an essential part of the industrial hygiene program. The industrial physician should be able to rely upon his local health agency to fight this rear-guard action in support of his front-line attack against time-loss in our war production drive. To help the States hold the line against preventable disease, the United States Public Health Service, under emergency appropriations by Congress, has recruited and trained 800 professional workers—physicians, engineers, nurses, technicians, and others—and assigned them to duty, under the direct supervision of State health departments, to critical war areas.

Thus, although actual performance still falls far short of immediate needs, a good beginning has been made in the provision of minimum public health facilities in war areas. Further improvement must come, in large part, through a more realistic facing of the problem by the States and communities involved.

Crowding, poor housing, lack of sufficient medical facilities, schools, recreation and other welfare services all combine seriously to threaten health and to disrupt normal family life. Add to these the mental strain caused by war worries, and we have a situation under which thousands of war workers are now living which is certainly not conducive to good morale and all-out production.

The disruption of community facilities, then, is one of the many influences of war upon industrial medicine; it is perhaps the first one to be felt in the industrial physician's practice, and equally one of the last to be recognized. Industrial medicine can no longer confine itself to emergency treatment and the diagnosis of occupational diseases. True, there is a bigger job to be done in the plant itself—that is, a job of prevention. But even this cannot be accomplished without a prompt and responsible recognition of the influence of living conditions upon absenteeism and industrial disability. This is "total war"; half-way measures, half-way acceptance of responsibility; and a half-way concept of the job will not win. In dealing with the worker, we must adopt a concept of the "total man" if we are to keep him on the job and enable him to contribute to the common cause—his utmost in high morale, vigor, and efficiency.

COMPOSITION OF THE WAR LABOR FORCE

The Manpower Need

The War Manpower Commission has estimated that at the end of 1942 about 18 million persons were at work in armament, shipbuilding, munitions, and construction industries. By the close of 1943, those figures will have increased to 22 million workers. If we add a reasonable number of employees in such essential industries as transportation, public utilities, food processing, and agriculture, the total war-labor force by the end of 1943 will be 30 million—more men and women employed in industry than ever before in our history.

Although the most conservative estimates indicate that the United States is statistically capable of meeting this demand for manpower, the feat of actually supplying manpower as needed is by no means simple. The induction of men into the armed services through the quota system in service commands, the geographical location of war industries, uneven distribution of war contracts, priorities, and conversion are all creating local and regional shortages of labor.

Employment of Women

The increased employment of women will be one of the most notable changes in industry as a result of the war. Of the 50 million women, 14 years of age and over, who were listed in the 1940 Census, nearly 16 million are already at work. The remain-

ing 34 million will probably comprise the Nation's principal labor reserve; not more than 13 million of these will actually be available to industry, however. Age requirements, the need for farm labor, maintenance of homes, and the voluntary services will serve to limit the use of this potential supply.

The War Production Board is encouraging the employment of women on the grounds that "employing a woman for any job that she can do or can learn to do will release a man either for work not suitable for women or for active armed service." According to the Women's Bureau of the United States Department of Labor,² women are already employed on lathes, automatic gear cutting or shaping machines, metal turning, core making, shell loading, certain tire making operations, and certain types of general labor work. Women have been found especially employable in our expanding aircraft production program, in instrument making, and in both small arms and artillery ammunition work.

In one American plane plant, women are now handling 38 different jobs, from milling machine and turret lathe operator to sewing machine operator and parts stamper. In the entire plant there are only nine jobs to which women definitely are not suited because of physical requirements, and five for which the required training is too long to warrant introducing women.

How does this unprecedented infiltration of women workers into occupations formerly open only to men affect the work of the industrial physician? The morbidity rates from various non-industrial diseases are higher among women than among men. For example, analysis of statistics reported to the Division of Industrial Hygiene, National Institute of Health, on 8-day or longer absences in certain industries, shows that sickness incidence rates for women are about 60 per cent higher than for male workers.³ The highest tuberculosis death rates are recorded among women in the employable age group, 15-24 years. The employment of women, especially in the heavy industries, presents numerous problems which industrial medicine must meet if war production is to use our womanpower to the best advantage.

Salvaging the Handicapped

To win the war, we must use *all* of our manpower. As a nation we have accepted the fact that until the war is over, there

will be no "business as usual" for any of us. Many peacetime standards will have to be revised. We are salvaging rubber, aluminum, copper, scrap iron, tin, so that we can meet shortages in strategic materials. Likewise, we must salvage those workers who are handicapped by both major and minor disabilities. Our physical standards for employment have been rigid and arbitrary, and in many cases, unnecessarily high. These standards are still being applied in war plants, and valuable workers with physical defects are being turned away.

The War Manpower Commission has already called upon management to review and adjust these standards to immediate needs. The industrial physician has a definite responsibility in influencing and guiding decisions with respect to the employment of handicapped persons. We have said for many years that the pre-employment examination *should* be used as a mechanism for the proper placement of workers. War has brought the demand that the pre-employment examination *must* be used as a tool to place *all* workers—including the physically handicapped—in jobs best suited to their capacities, jobs in which performance will be at required efficiency without unusual hazard to the worker or his associates.

The rehabilitation clinics, with follow-up, provision of orthopedic appliances and training, and employment, offer a possible mechanism for prompt adoption of a more liberal policy with respect to the utilization of handicapped workers. The United States Public Health Service, the U. S. Employment Service, and the Office of Education stand ready to assist management, employment departments, and industrial physicians in war plants in the formulation of standards, the referral of handicapped persons for employment and in the training of such workers for suitable jobs.

Detailed knowledge of the jobs in a given plant should be a part of the industrial physician's equipment—not merely knowledge of the number of vacancies, but of the actual operations, the potential exposures, and the required physical capacity for each operation. This kind of knowledge is not to be acquired by reading reports, but by personal study of the problem in the shop. Knowledge of the job combined with the physician's knowledge of the human organism will make it possible to salvage many thousands of physically handicapped workers for participation in the war production drive.

PROBLEMS OF THE WORKING ENVIRONMENT

The most direct impact of the war upon industrial medicine lies in the fundamental changes that have taken place within industry itself and particularly in the speed with which these changes have taken place. New machinery, new processes, new substances—all have been introduced with incredible speed. Each change offers a direct challenge to the industrial physician, whose task is to reduce or prevent illness and accidents in the plant. Each change offers a direct challenge to the general practitioner in an industrial community. Very often, he is the first to see the results of toxic exposure, of industrial accidents and fatigue. In a zealous attempt to obtain peak production, both management and workers are likely to overlook conditions affecting health, or perhaps do not even recognize them until some unfortunate incident results in sickness, injury, and lost time.

The conversion of peacetime industries to war production has introduced innumerable factors affecting the health of workers. The men and the machines of the automobile industry were both accustomed to working with steel; they have had to be "converted" to the use of aluminum for planes. An automobile body called for the assembling of 600 pieces; one pair of wings has 6400 pieces.

Electric Welding

One of the most significant changes in industry today is the greatly increased use of the electric welding arc.⁴ It has revolutionized shipbuilding, and in doing so, has enormously increased the number of workers exposed to serious hazards. Industrial medicine has known the potential hazards of welding for a long time, effective methods for control are also known, but their application has been "too late and too little," in many plants. The supply of protective and control equipment has not kept pace with the demand, in some areas, it is true; but needs are too urgent to discount the fact that protective measures *could* have been, and *should* have been devised. Frequently, measures have not been taken to shield the arc and protect other workers in the vicinity from welding flash, or to remove toxic gases and fumes with local exhaust ventilation. Burns, dangerous ultraviolet radiations, severe and even fatal poisoning from oxides of nitrogen fixed by the arc, metal fume fever due to zinc oxide fumes produced when welding galvanized iron, carbon monoxide, and other

toxic exposures—these are specific problems which war has presented en masse for the first time in the experience of many industrial physicians.

Use of New, Toxic Substances

Another direct effect of the war upon the industrial hygiene problem is the substitution of more toxic or new and unknown substances, for materials that have been proved less toxic. For example, benzene, with its known harmful properties, had been abandoned as a solvent by many industries. Now, benzene is being reintroduced as a substitute for toluol, a relatively safe substance, which is an essential ingredient in making TNT. A shortage of benzene, even, is threatened, which may result in the use of solvents of unknown toxicity or of toxic halogenated hydrocarbons. Indeed, many new solvents have already appeared on the market, and although it is claimed that they are nontoxic, some of them are in the chlorinated hydrocarbon group of chemicals. Certain members of this group—carbon tetrachloride and trichlorethylene—are known to be toxic; in the meantime, the new solvents are being used without benefit of investigation.

Reintroduction of Silica Sand

Twelve years ago steel shot or grit was introduced widely as an abrasive in blasting operations to replace silica sand.⁵ Today silica sand is being reintroduced as the result of steel shortages and the hazard of silicosis in blasting operations is again in the foreground. Likewise, new dust hazards have been introduced where steel cutting instruments have been replaced with silicon carbide instruments.

Cutting Oils

The vast increase in the use of cutting oils has increased the occurrence of industrial dermatoses. We have recently encountered two unusual cases of poisoning from cutting oils. In one, the cutting oil had been treated with sulfur chloride; a dermatosis similar to chloracne resulted. In the second, sulfur had been added to the cutting oil; in the process, machine threads were cut with silicon carbide abrasive wheels; enough hydrogen sulfide was thus liberated to cause poisoning.

Fatigue

No discussion of the health hazards in the working environment would be complete without mentioning fatigue. Associated

closely with fatigue is overtime. Studies show that the effects of fatigue, whatever its origin, result in lessened production, increased labor turnover, increased accidents and absenteeism, and higher compensation costs. From two-thirds to three-fourths of the workers in key war industries are putting in from 10 to 12 hours overtime every week. Studies both in Great Britain and in this country have shown that for *sustained* production the optimum number of hours of work is 48 in a 6-day week.⁶

Also associated with fatigue is the disruption of eating and sleeping habits among workers employed on second and third shifts, especially with change of shifts occurring too frequently.

Physical fitness in the workers is the basic requirement for the reduction of lost time due to fatigue. Proper adjustment of hours, improvement of the working environment, job simplification, reduction of noise, and provision of rest periods with supplementary feeding will contribute to the control of fatigue.

Improved nutrition is an important factor, not only in combating fatigue, but also in promoting a higher level of health.⁷ Up to now industry has paid little attention to the nutrition of workers. Some of our newest plants are making no provision for cafeterias in the establishment, or even convenient to the plant. Great Britain has had to make the provision of eating places compulsory in all factories employing 250 or more persons. Similar action may be expected in this country if the present educational program fails to produce results.

Demands on Industrial Physician

The industrial physician may well feel that if war conditions do not overwhelm him by their magnitude, they will overcome him by their complexity. Alloys of unknown or implied industrial hygiene significance, toxic metals such as cadmium, increased radium dial painting for precision instruments, the use of radium and of X-rays for the detection of flaws in metal castings and forgings—all offer new or seldom-encountered problems to the physician. Many of these industrial health hazards and the methods to control them are discussed in the subsequent chapters of this handbook.

Yet, these and countless other health problems in war industries can and must be solved. There is only one answer which this nation and her Allies can give to the Axis; that answer is spelled in guns, tanks, planes, and ships. If these materials are to flow in that continuous river demanded by the President, every

working hour must be saved that can be saved; every workman must be helped to do the job he wants to do for his country.

Our air force has the answer for industrial medicine. We do not hear about a pilot, or a navigator, or bombardier any longer. We hear about a "crew," a team—operating with incredible skill and bravery, each dependent upon the skill and loyalty of the other. The industrial physician can meet his enemy—carry out his mission—if he learns to operate as a team, drawing upon all the resources available to him. Teamwork begins in the plant, between management, the medical service, the engineering service, and the employment department. Other resources should be utilized as well: the private practitioners of medicine in the community; Federal and State industrial hygiene services; local public health authorities—all should be focused upon the supreme task now before us, namely, the conservation of manpower in our war industries.

SHORTAGE OF TRAINED PERSONNEL

The fourth wartime problem—the shortage of professional personnel—makes teamwork in industrial medicine even more imperative. Reports to the United States Public Health Service indicate that in hundreds of industrial communities, the lack of physicians, dentists, and nurses is acute and in many, the situation is indeed grave.⁸ As early as February, 1942, Surgeon General Thomas Parran reported that there were 1000 vacancies for qualified physicians in State and local health departments, and 2700 vacancies for public health nurses. In civilian hospitals, there are 10,000 vacancies for registered nurses. Individual cases have come to our attention in which the staff of industrial medical services in war plants is being depleted by the induction of personnel into the Army or Navy.

The Procurement and Assignment Division of the Manpower Commission is pressing forward as rapidly as possible with its program for the effective utilization of the medical and dental personnel of the nation. Even with adequate adjustment of the present situation, we must all face the fact that there will be a considerable shortage of professional personnel. The needs of our increasing Army and Navy must be met.

Nevertheless, there is a growing concern on the part of numerous War Agencies, and the Council on Industrial Health of the American Medical Association, lest adequate measures not be taken for the health protection of our vast industrial army.

This would seem to place industrial medicine on the horns of a dilemma.

To help meet this problem, the Public Health Service has increased the staff of the Division of Industrial Hygiene of the National Institute of Health to 200, and has in addition employed and given special training to 60 industrial physicians, engineers, and chemists who have been assigned to duty in State industrial hygiene services. There is available, then, in the Federal service and in the 45 State and local industrial hygiene units, an organization of approximately 500 trained professional workers capable of giving active assistance to the industrial physician. Through inspection of plants, medical and engineering consultation, and laboratory services, an effective program for the health protection of workers in individual plants is available. It only remains for these services to be more widely used by industry than they are today.

The problem of providing medical service in small plants is of increasing importance, since the allocation of government contracts has brought many of them into the war production drive. The Council on Industrial Health of the American Medical Association, in a recent joint session with the Subcommittee on Industrial Health and Medicine of the Federal Security Agency, recommended that a program of instructing management in the advantages of medical supervision over workers be undertaken by the Government. At the subsequent meeting of the National Conference of Governmental Industrial Hygienists, the Conference recommended that a similar program be undertaken by the Public Health Service.

In closing this discussion of war's impact on industrial hygiene we must keep in mind that *time* is indeed of the essence—time to outstrip the start which our enemies have had on us for many years. Indeed, our shortages of certain vital materials and of professional personnel are insignificant compared to our shortage of time. There is no substitute for the hours and days lost in war production because of disabling sickness. There is no substitute for the lives lost in accidents. Industrial hygiene has the clear responsibility and the prodigious task of conserving every ounce of energy and efficiency in our war workers. The new and renewed problems are troublesome; but in most instances, we know how to meet them. War hits hard and it hits fast—in every phase of our national life. The industrial hygienist must hit first

and hit harder if we are to give our working army the health and strength necessary for victory.

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CHAPTER 2

PLANT MEDICAL FACILITIES

O. F. Hedley, M.D., F.A.C.P.

THE PLANT INFIRMARY

THE immediate and future development of an adequate medical program is dependent in no small measure upon how the infirmary is built and equipped. Too often the usefulness of a medical department has been seriously handicapped or even permanently impaired because of an inadequate or poorly designed infirmary. Due to the growing shortage of personnel it is even more imperative under existing conditions that the medical department be housed adequately and equipped properly.

Architectural Fundamentals

The time to begin planning the infirmary is as soon as possible after the plant site has been selected. The medical director should be one of the first officers selected, and the permanent plant infirmary built in time to serve construction as well as permanent activities.

In many industries converted to war work, the medical director often reaps the results of plans, be they good or bad, of his predecessors. Here it is often a matter of "what cannot be cured must be endured." The chances are that the medical department alone is not suffering from dilapidation and short-sightedness. Even under wartime conditions it is often economical to construct a new personnel building to house the personnel, safety, public relations, medical, and other departments concerned with orienting new employees, plant protection, health, and other matters pertaining to improved relations with employees and the public. A new temporary structure may be a great improvement over an old permanent building.

Generally speaking, physicians are particularly inept designers. The average physician is as much stepping out of his normal role if he attempts to work out the details of planning an infirmary as is an architect who attempts to operate one. The medical director should be able to outline the essentials and leave

the details to those who have made a life's work of preparing plans and specifications. When the medical director attempts to design the infirmary, he is too often likely to be guided by preconceived ideas based on his experience in a general hospital, possibly the hospital where he interned many years previously. He may also be guided by the plans of an infirmary of a plant where he previously served, or by a plant infirmary which appeared satisfactory during a cursory visit. In any event, if left too much to his own devices, he is likely to bring down coals of fire on his head for his impetuous enthusiasm.

On the other hand, many designers of industrial plants have little experience or appreciation for the architectural requirements of a plant infirmary. They are likely to look upon the medical department as an accessory, rather than as a highly important component of the industry. Because of this attitude it is often difficult for the physician to convey the desirability of designing an infirmary in a given manner. Consequently, the medical director is likely to find himself saddled with an architectural monstrosity not of his own choosing.

In all but the smallest plants it is sound economy to obtain the services of a reliable consultant architect experienced in designing hospitals and health centers. This architect is often able to prevent mistakes otherwise destined to result in wastage of time and expense both to the industry and its medical department. The medical director is more likely to get the kind of infirmary he desires if his ideas are sound, and at the same time having it embody the latest developments in hospital design and equipment.

INFIRMARY VERSUS HOSPITAL

Many thousands of dollars frequently could be saved both in construction and operation if before construction the medical director and other responsible officials would answer this question, "What is this supposed to accomplish?"

Save in infrequent instances, the building will not be used as a hospital. To construct it as such, or even to designate it as the "plant hospital," conveys an improper impression. The term "hospital" connotes an institution devoted to prolonged in-patient treatment. To label the average plant infirmary with the high-sounding title "hospital" is comparable to terming a small liberal arts college a "university." It is neither honest nor descriptive.

Psychologically the term "plant hospital" is a poor designation as it implies to the worker that the medical department is

primarily concerned with the treatment of severe casualties whereas its real purpose should consist of preventing or minimizing disabling diseases and injuries.

Hospital treatment should be furnished at the plant only as a last resort when hospital facilities in the community are not available or cannot be developed. In this case it may be necessary to develop a plant hospital in the true sense of the word. These facilities may have to be made available to the families of employees. Owing to the increasing shortage of physicians and difficulties in constructing civilian hospitals, the desirability of using the plant hospital for the care of nonindustrial cases should always be given consideration, particularly in isolated localities or "boom" towns. The hospital should be located outside the plant enclosure if it is likely to be used for this purpose.

APPRAISAL OF EXISTING COMMUNITY FACILITIES

Even before beginning construction on a new war plant, an appraisal should be made of such community facilities as hospitals, the health department, schools, water and sewerage systems, and mosquito control.

Surveys by Federal Agencies

The war industry or responsible Government officials should ask the District Director of the U. S. Public Health Service for a survey to determine the adequacy of hospital and health facilities, while surveys on other community facilities are conducted by the Federal Security Agency through its Defense Health and Welfare activities. The Public Health Service Districts are constituted as follows:

District No. 1. Comprising the States of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Delaware. Headquarters office: Sub-Treasury Building, 15 Pine Street, New York.

District No. 2. Comprising the States of Maryland, North Carolina, Virginia, West Virginia, and the District of Columbia. Headquarters office: National Institute of Health, Bethesda, Maryland.

District No. 3. Comprising the States of Illinois, Indiana, Michigan, Ohio, Wisconsin, and Kentucky. Headquarters office: Room 855, U. S. Custom House, 610 South Canal Street, Chicago.

District No. 4. Comprising the States of Alabama, Florida, Georgia, Louisiana, Mississippi, Tennessee, and South Carolina. Headquarters office: 1307 Pere Marquette Building, New Orleans, Louisiana.

District No. 5. Comprising the States of Washington, Oregon, California, Nevada, and Alaska and Hawaii. Headquarters office: 1223 Flood Building, 870 Market Street, San Francisco, California.

District No. 6. Consisting of Puerto Rico and the Virgin Islands. Headquarters office: San Juan, Puerto Rico.

District No. 7. Comprising the States of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Minnesota, Iowa, Missouri, and Arkansas. Headquarters office: 603 B. M. A. Building, Kansas City, Missouri.

District No. 8. Comprising the States of Montana, Idaho, Wyoming, Utah, Colorado, and Arizona. Headquarters office: 617 Colorado Building, Denver, Colorado.

District No. 9. Comprising the States of Texas and New Mexico. Headquarters office: Mercantile Bank Building, Dallas, Texas.

If the results of these surveys indicate an insufficient number of hospital beds to care for industrial cases together with the anticipated increase in the general population, efforts should be made to stimulate the community to add to existing facilities. It is much better to augment local hospitals than to provide a plant hospital capable of meeting all contingencies. In most war industries the plant hospital would have to be located inside the plant and could not be available for the families of war workers. Furthermore, since many war industries are constructed to last for only a few years, the construction of a large plant hospital often represents an unwise expenditure. As noted previously, however, it may be necessary in some instances for the plant medical department to furnish or to make its facilities available for general medical care.

Effect of Priorities on Construction

Because of the priority situation, particularly as relates to structural steel, copper, and elevator equipment, community facilities for the remainder of the war will probably be limited to single-story pavilion-type structures. There has been a hesitancy on the part of communities to agree to the erection of such buildings which are erroneously regarded as "temporary." Many of these hospitals are brick buildings, and, except for the fact that they may not blend well with the prevailing hospital architecture, cannot be regarded as makeshifts. Even though they are built of wood or asbestos board they are quite serviceable and designed to last a number of years. Prejudices against them are unwarranted, particularly in times of stress.

LOCATION OF PLANT INFIRMARY

In most plants, the infirmary consists of the ground story of a wing of the personnel building which also houses the personnel, safety, and sometimes the plant security departments. In

some instances, a separate building is provided for the medical department. Because of the close relationship of the medical department to the personnel department in the performance of pre-employment physical examinations, this arrangement is not so satisfactory as having both departments under one roof.

In locating a medical department, consideration should also be given to the following:

1. Access to natural light and ventilation.
2. Freedom from noise and vibration.
3. Accessibility to the greatest number of workmen.
4. Allowance for expansion.
5. Accessibility to roads from various parts of the plant and to the nearest hospital.
6. Safe distance from hazardous operations in event of disaster.
7. The possibility of its being used for the nonworking population. Accessibility to visitors and other persons has to be considered.

SIZE AND TYPE OF INFIRMARY

Concerns employing up to 5000 to 7000 employees during the largest shift require approximately one square foot of space in the main infirmary, exclusive of substations, per employee, based on the number of employees on the largest shift. Additional space, other than for storage, is not required for additional shifts since the same facilities can be used throughout the 24-hour day. Where more than 5000 to 7000 persons are employed, proportionately less than one square foot of infirmary space per employee is required.

The type of structure is dependent upon the prevailing architecture, that is, a wooden, asbestos board, or similar building if designed only for the emergency, a brick building if part of a permanent plant. To facilitate the most expeditious processing of new employees, the infirmary should be part of the personnel building. It is thus possible to interview, classify, photograph, fingerprint, and physically examine applicants under a single roof. This reduces the possibility of sabotage by preventing unauthorized persons from wandering around the plant under the pretext of seeking employment.

Except in the smallest plants, the part of the infirmary devoted to preemployment physical examinations should be separated as much as possible from that part devoted to the treat-

ment of injuries and to periodic physical examinations. This may be accomplished by having the entrance to the physical examination section from the personnel offices, and the entrance for ambulatory patients from the interior of the plant. It will be necessary to have certain common facilities such as X-ray equipment and the laboratory, but the arrangement described will reduce the frequency with which new employees come into contact with injury cases, and will prevent unauthorized persons from gaining access to the plant through the medical department.

ESSENTIAL FEATURES OF A PLANT INFIRMARY

As outlined elsewhere, the functions of a plant medical department consist primarily in the physical examination of applicants, periodic examinations to prevent occupational diseases, such other annual or other periodic examinations as the number of medical personnel will permit, the treatment of ambulatory cases of industrial injuries and occupational diseases, the treatment of minor nonoccupational diseases developing while the employee is at work, and advice to employees about conditions which may incapacitate if not treated promptly. Hospitalization for industrial injuries and occupational diseases and treatment of nonindustrial diseases or injuries are not generally contemplated.

The infirmary should be built with these considerations in mind. While it is not within the scope of this manual to state in detail how each infirmary should be built or equipped, certain suggestions are offered with the aim of reducing the number of pitfalls frequently encountered in the design and construction of plant infirmaries:

1. Develop a clear conception of the purpose for which the infirmary is intended and the number of workers it is expected to serve. This calls for vision and a realization that it is easier to obtain the proper building during the construction period than after operations are begun.
2. Take into consideration the area to be covered. Substations will be required if large numbers of workers are located in buildings even a few hundred yards from the infirmary. Substations with rest rooms will be particularly necessary if women are employed in appreciable numbers. Where workers are engaged in toxic operations, the periodic examinations should be done as near the site of operations as possible, to reduce time loss to a minimum.

3. Avoid overbuilding. Too many plant infirmaries approximate the Mayo Clinic in size and Rube Goldberg in design. In planning a dispensary, consideration should be given the inescapable fact that because of the requirements for physicians and nurses for the armed services, it will be increasingly difficult to obtain trained personnel for plant medical departments. A large, unwieldy, but understaffed medical department adds to the difficulties of efficient operation. Efforts should be made to take advantage of labor-saving devices wherever possible. Compactness is the order of the day.

In planning a plant infirmary there are a number of details which should be borne in mind. It is not intended that these shall apply to each and every infirmary. These suggestions are offered as a general guide to enable the medical director to plan his infirmary in a manner calculated to attain efficient results. Experience has shown that there are features which should be emphasized, and mistakes which should be avoided.

Waiting Rooms

Usually a single waiting room will suffice. As the objective of a well-run medical department should be to examine applicants and treat patients as expeditiously as possible, the waiting room should not be too large. It is also unnecessary to provide separate waiting rooms for males and females. The waiting room should have an entrance from the plant side of the infirmary to facilitate the examination and treatment of sick or injured employees, and various types of periodic physical examinations. Insofar as is practicable, periodic preliminary examinations of workers exposed to toxic substances should be performed in substations, lunchrooms, or change houses near the lines in order to reduce loss of time due to these examinations. A certain number will be referred to the main infirmary for more complete examinations involving laboratory studies. The waiting room in the adjacent personnel department should be used for applicants awaiting preemployment examinations.

Control Point

Regardless of the size of the infirmary some kind of control point should be established to enable proper and constant supervision by a qualified employee of all persons entering the infirmary. In a small infirmary it may consist of a desk with files

nearby; in a larger infirmary it may consist of a booth or window where a nurse or clerk may obtain a history and have ready access to the record file.

Filing Space

Filing cabinets may be located in the waiting room or immediately adjacent. Except for relatively small infirmaries, a separate record room should be provided to insure greater privacy. Too often the records of a medical department are filed in the personnel department or elsewhere because of inadequate space in the infirmary. The efficient functioning of the medical department and the ethics of industrial medicine make it necessary for the medical records to be retained in the medical department. These records should only be available to members of the medical department and should be regarded as confidential.

Like most hospitals, medical departments find that records tend to accumulate much more rapidly than anticipated. Sufficient space should be provided at the outset.

Treatment Rooms

Even in the largest infirmaries, one room for the treatment of ambulatory patients will usually suffice. If more appear indicated, better utilization of substations would appear indicated. The equipment for the treatment rooms should be sufficient, but unwise expenditures avoided.

One of the chief problems in treating ambulatory patients is the danger of fainting with consequent injury due to falling. Obviously it is not practicable to place every ambulatory patient in a recumbent position. In some industrial infirmaries this problem has been met by a horizontal bar at waist height against which the patient can lean if he begins to feel faint. Barber chairs which can be rapidly tilted to a recumbent position have also proved particularly satisfactory.

Operating Rooms

Except in special cases, such as the location of the plant at a great distance from a hospital, or the existence of a special hazard, it is doubtful if an operating room is required. Most plant physicians do not perform a sufficient number of operations to keep in practice nor are anesthetists or other members of a surgical team readily available. It is often difficult to provide meals for in-patients, while nursing service for an occasional

surgical case proves extremely expensive. It is much better to plan to send such patients directly to a local hospital.

If an operating room is provided, it should be equipped to handle the type of cases likely to be encountered. This may vary from such instruments as are required to control hemorrhages and temporarily immobilize fractures to equipment sufficient to enable the surgeon to reduce compound fractures or perform laparotomies. The decision concerning the kind of equipment should be based on the potential frequency with which an operation is contemplated.

Eye Treatment Room

If eye injuries are common, a special room should be equipped and devoted to this purpose. It should be so arranged that examinations requiring a dark room may be made.

Eye Examining Room

The visual requirements for employees vary with the minuteness of the work involved. This should be foreseen when planning the infirmary. In many industries the Snellen chart will suffice, at least for most of the workers. This examination may be given in a hallway, or a smaller room may be used if mirrors are provided. In other industries, tests with telebinocular instruments for near vision, muscular balance, color vision, and depth perception may be required either for all or varying numbers of workers. These have the added advantage of detecting malingering or fraudulent attempts to qualify for positions requiring high visual standards. It is frequently advisable to provide facilities for refractions, particularly if corrected safety glasses are worn. In the larger infirmaries, the eye examination should be performed in a room separate from the physical examination room. This enables a nurse or other attendant to perform this part of the preemployment examination, thus saving the time of a physician.

Rest Rooms and Wards

Since in most plants treatment in the infirmaries will be confined almost exclusively to ambulatory cases, wards will not be required. It is necessary, however, to provide beds for employees who have become ill, or become faint after minor injuries. Insofar as possible, rest rooms should be provided at the substa-

tions near the various operations. This reduces contact of casually ill employees with those who have received injuries of varying degrees. Both in the rest rooms in the substations and at the infirmary, separate provision should be made for men and women.

Examination Rooms

The type of examining room will depend largely upon the thoroughness of the examination, and the number of female employees. In a war industry, particularly during the construction phase, it often becomes necessary to streamline the physical examination to permit a few physicians to examine rapidly a large number of applicants. The medical history, tests for vision and hearing, blood pressure determinations, various measurements, and laboratory work should be performed by qualified assistants before the physician is reached. Under normal circumstances the physical examination should be performed in the privacy of a physician's office. Time may be saved by providing two dressing booths with doors opening toward the hallway and to the office so that an applicant may be disrobing while another is being examined. Where a large number of men are being examined it is often desirable to examine them in a large room en masse in groups of as many as 10 to 12 at a time. Here they are lined up and the physician systematically examines various organs and parts of the body and denotes positive findings to a male clerk. In this manner one physician can examine a number of applicants with a reasonable degree of accuracy in a short period. Provision should be made for such a room if it seems likely that this type of examination will be required.

Where female workers are to be employed, provision should be made for individual examinations. Disrobing booths with entrances to the examining room and the hallway facilitate these examinations.

Laboratory

The average laboratory of a plant infirmary need not be large. It should provide facilities for urinalyses, routine blood studies, and specific tests in connection with toxic operations. Except where public facilities are not available, a plant infirmary should not attempt to perform serodiagnostic tests for syphilis because of the overhead expenses involved and difficulty in obtaining competent serologists. Even though a plant employs ten thousand

workers, the average number of tests per day after operations are begun will not usually justify this expenditure.

The toilets should be located adjacent to the laboratory so that urine specimens may be handed through a window.

X-ray Facilities

These should be available for preplacement examinations, diagnosis of injuries, and such treatment as may be indicated. The decision as to the extent to which the plant should provide these facilities should be based on the number of employees, the hazards involved, and existing facilities in nearby hospitals. In general, these facilities should be limited to diagnostic apparatus. Therapeutic equipment is indicated only in exceptional cases.

A plant with less than 2000 employees will not usually require X-ray equipment unless a hospital is inaccessible. In plants of over 4000 employees, it is usually economical to provide an X-ray machine of over 200 milliamperes capacity with a photofluorographic attachment for miniature X-rays. Savings in the cost of these miniature films justify a greater initial outlay. In the plant of intermediary size or smaller plants, chest X-rays should be obtained with the conventional 14 by 17 inch film, or by periodic surveys conducted by the State health department or the U. S. Public Health Service.

In purchasing X-ray equipment it should be borne in mind that the cheapest machines are often not the most economical. Also, in determining the need for X-ray equipment, consideration should be paid developing solutions. All X-ray equipment should be shielded and the rooms lead lined on the basis of standard specifications.

Physiotherapy Apparatus

In most plants the physiotherapy apparatus need be limited only to an infra-red machine. In the larger plants a physiotherapy room may be provided which should contain a whirlpool bath and diathermy machine. Ultraviolet machines are not usually indicated.

Some plants have obtained gratifying results in the use of infra-red machines for the treatment of menstrual pain.

Ambulances

Except where hospital facilities are readily available as in a large city, a plant with as few as one thousand workers may

require an ambulance if the operations are hazardous, such as the manufacture of explosives. Most war industries are located in or near cities and are engaged essentially in machining operations. Unless quite sizable, these will not usually require an ambulance.

The ambulance should be kept in a heated garage and should be equipped with an adequate heater to insure maximum comfort and reduction of the likelihood of shock. Equipment should also include blankets and hot water bottles. Recently, some plants have been equipping their ambulances with electric blankets. In addition to the usual first-aid kits, the ambulances should contain splints for the temporary immobilization of fractures of the extremities.

In plants in which there is danger of explosions involving injury of a number of workers, a designated stock of blankets and hot water bottles should be kept at the infirmary where they may be placed in an ambulance at a moment's notice.

Storage Space

As in the case of filing space, there is a tendency not to provide sufficient space for storage. Government purchasing regulations for Government-owned, contractor-operated plants and sound economy require purchases of relatively large quantities of supplies. The desirability of adequate storage space can hardly be overestimated

Office Space

Offices should be provided for the medical director, members of the medical staff, and, in the larger infirmaries, the nursing supervisor. Where individual physical examinations are made, the physicians may perform these examinations in their offices, particularly if booths for disrobing are provided. Insofar as practicable each physician should have an individual office.

Substations

Where distances of greater than a few hundred yards are involved, particularly where women are employed, substations under the charge of a nurse should be provided. These substations are especially essential in munitions plants in which employees do not have access to areas other than those in which they work. Here the substations may be used for periodic physical examinations of workers exposed to toxic substances. The sub-

stations need not be large. They should consist of a first-aid room, toilet, a nurses' dressing room, which may also be used for storage, and one or two rest rooms, usually of two- to four-bed capacity. The primary function of these substations should be to prevent loss of time incident to visits to the plant infirmary. Insofar as possible, most cases requiring only rest should be treated in the substations.

CONCLUSIONS

The plant infirmary should be designed with the same care as is afforded other departments of a plant. Although overbuilding should be avoided, the infirmary should be planned with a view to the most efficient use of personnel, bearing in mind that the shortage of physicians and nurses is almost certain to become more acute during the next few years. It is strongly suggested that assistance from architects specializing in hospital plans be obtained, especially in the larger infirmaries.

As a general rule, the plant medical facilities should be designed primarily for the ambulatory treatment of injuries and occupational diseases. Patients requiring in-patient treatment should be sent to existing hospitals.

Efforts should be made to stimulate communities to augment health and hospital facilities. The plant medical department should seek an appraisal by State or Federal agencies of these facilities. It should avail itself of laboratory and other facilities offered by outside agencies wherever possible.

Recommendations have been made concerning the location, size, essential requirements, and certain equipment for these infirmaries. Consideration must be given the number of employees, number of women, the area covered, and the type of work.

CHAPTER 3

ORGANIZATION OF PLANT MEDICAL DEPARTMENT

O. F. Hedley, M.D., F.A.C.P.

THE underlying philosophy of this chapter and the chapter on *Medical Services* which follows is based on a realization that the country is at war and that medical services, the same as many other basic services and commodities, will have to be rationed. It is the old story of having to do "so much" with "so few." It serves no useful purpose for the official industrial hygienist to advise the plant medical director that he needs six physicians instead of four, when two of these are about to be inducted into the Army. It would serve a much more useful purpose if the harassed medical director were better informed concerning the most efficient utilization of his available staff. Furthermore, the situation is likely to deteriorate.

ADMINISTRATION

Departmental Authority

The most efficient functioning of a medical department requires that the medical director have access to top management, that is, to the president or general manager. In the scheme of organization the plant medical department should be made administratively responsible to one of these officials.

The problems of the medical department are so diverse as to make it desirable for the medical director to be on a parity with many of the key plant officials, yet responsible to none of them. In his daily duties he will have intimate contact with the safety department, the personnel department, welfare organizations, the production department, the legal department, and other sections of the plant. The effectiveness of the medical department may easily be curtailed if it is placed under a department head who is unsympathetic to its aims or, on the other hand, has a desire to dictate its policies.

Functions of Department

One large munitions plant, upon establishing its medical department, issued the following directive which might serve as

a model in defining in a succinct manner the duties of a medical department and its relationship to other activities:

We herewith announce the establishment of a Medical Department as a separate department of our organization.

Dr. John Doe has been appointed medical director in full charge of this department; he has already assumed his duties.

The medical director, as responsible head of the Medical Department, will be in full charge of the following activities, some of which are already established and others are in process of organization:

1. All medical personnel, including staff physicians, nurses, laboratory technicians, and ambulance drivers.
2. The hospital and its staff. All first-aid stations.
3. Preemployment physical examinations.
4. Postemployment periodic physical examinations.
5. Preventive medicine throughout the plant area.
6. Plant sanitation and all so-called "Public Health" activities, except the construction and maintenance of physical facilities therefor, in which he will serve as advisor to the Water and Sewer Departments.
7. Liaison with our insurance company with respect to accident cases and other medical matters; maintenance of records and statistics regarding accidents and other medical information.
8. The operation of an ambulance service.

Dr. Doe or members of his staff will call upon you from time to time for information relating to his activities; your cooperation on these requests will be expected.

RICHARD ROE

Manager, Engineering and Operations

The above sets forth the position, duties, and authority of the medical department without cant or equivocation. In the language of the Scriptures, it is written "plain upon the tables, that he that runneth may read it."

Position of Branch Establishments

One of the most important factors to be determined is the relationship of industrial medical establishments of branch plants to the home office and to the central medical establishment. This should be clearly defined at the outset. So long as this relationship is clearly understood, its nature is often of secondary importance. The writer knows of two famous industrial concerns, both having excellent medical divisions, one of which is operated on a highly centralized basis, while in the other the chief medical officer has the title and duties of medical consultant. In one the program is unified and standardized, while in the other much more is left to the discretion and initiative of the individual medical directors. Both systems serve their purpose. The main

objective should be to obtain good physicians and to give them sufficient support.

Often industries with little or no previous medical experience are given war contracts as in the case of shell-loading plants. For the present the temporary branch engaged in war production may be the larger part of the business. In such an instance a more decentralized program is usually indicated as the parent office or its medical department may not be cognizant of problems requiring prompt attention.

COSTS

Based on studies by the National Industrial Conference Board,¹ the American College of Surgeons,² and the National Association of Manufacturers,³ the average cost of a medical program, exclusive of compensation and the safety program, ranges from five dollars to ten dollars a year per employee. These excellent brochures should be on the "must" reading list of every medical director. The cost will vary with the size of the plant, being greater in the smaller plants than in large industries. It also varies with the type of industry, being highest in mining and lumber industries and lowest in food and kindred products and in shipbuilding and other construction. The chemical industry occupies an intermediary position.

Owing to the exigencies of the present emergency and to increased salary scales, programs will probably cost more than ten dollars per employee per year in many munitions plants, especially where hazards from exposure to chemical substances are involved. Such expenditures, together with adequate funds for safety and industrial hygiene, are justified because of the necessity of maintaining the human element in war production at the peak of efficiency. With the drawing of more older workers and women into industry, the needs for sound medical programs will be enhanced. Because of the shortage of physicians, the ratio of nurses should be increased even though greater expenditures are involved.

PERSONNEL

The Medical Director

The day has long passed, if it ever occurred, when a business concern could afford to entrust the health and well-being of its employees to any physician whom it could hire at a bargain salary. A poorly directed program may prove expensive not only

in dollars and cents but in a failure to maintain the good will of employees and the respect of the community.

The medical director should be more than a good physician, as important as this may be. He should be possessed of qualities of leadership, a sterling character, and the respect of professional associates, plant officials, and the employees who will be his patients. He should have mature judgment, a sense of values and proportions, and a quiet but radiant sense of humor. He should be able to laugh at situations but not at individuals. He should be able to supervise and direct the manifold operations of a medical department. Whatever his previous background, his professional standing should be above reproach.

Given the proper attitude and support, the question of his previous professional experience is often of secondary importance. Physicians with training in surgery, internal medicine, general practice, or public health have all made excellent plant medical directors. Indeed, it would not be difficult to cite examples of young physicians just finishing their internships who have directed the medical departments of large concerns in a creditable manner.

The medical director need not be an industrial surgeon. In a small plant, he may not have a sufficient variety of cases to maintain his technique, while in a large plant this responsibility may better be delegated to a member of the staff or to a consultant.

Whether the medical director is retained on a full-time or part-time basis is dependent upon the size of the plant and the availability of physicians. If there is a matter of choice between a part-time medical director and full-time assistants or vice versa, it would seem advisable to have a full-time medical director and depend upon part-time physicians for assistance and consultants. The custom of obtaining a "big name" surgeon for part-time medical director is to be deplored. Such a physician lacks the time or incentive to develop a well-rounded program. Too much emphasis is likely to be placed on reparative surgery at the expense of other essential features.

Plant Physicians

Owing to the exigencies of war, it is becoming increasingly difficult to obtain the right sort of physicians at a salary which industry thinks it can afford. This means that industry will have to pay larger salaries or curtail the activities of the medical departments. The number of physicians, however, is limited, and

regardless of industry's ability to pay, the supply will have to be rationed if the armed services, health departments, the public, and industry are to be served in anything approaching an adequate manner.

There is probably no more completely satisfactory solution to this shortage than there would be in attempting to feed the population on 2000 calories a day. Someone is going hungry! Industry should take a realistic view and attempt to find means of conducting its essential medical services, at the same time having an appreciation for the needs of the community. Where the number of physicians in private practice falls below certain requirements, workers may actually lose time because of illnesses among their families, which require their presence at home. It therefore becomes necessary to view this situation broadly, and attempt to fill all of these needs in the best manner possible under trying circumstances.

Use of Part-Time Consultants.—So far as possible, industry should utilize the services of part-time consultants. This will result in fewer doctors at the plant but will spread the services of the remaining physicians to meet the requirements of the plant and the community. The part-time services of practitioners will have to be utilized at the plant, particularly in smaller plants, to a larger extent than has been done previously. Older physicians, even those who have retired, will have to be given positions. Physicians with handicaps which render them unfit for military service or who have been discharged from the armed forces because of physical handicaps should be sought after.

Engaging in Private Practice.—The question is raised of the extent to which industrial physicians on a so-called full-time basis should be permitted to engage in private practice. Prior to the active participation of this country in hostilities, physicians were often employed on a 40-hour weekly basis, and were permitted to engage in private practice. In well-established communities this would cushion the effects of the post-war period by enabling these physicians to build up even a partial practice. In the temporary war industrial areas it would seem better to lengthen their hours of work at the plant, pay them better, and not permit outside practice except in instances where the dearth of physicians requires it. It would seem better to get along with fewer full-time physicians devoting all of their energies to the plant. This would release other physicians who would be ~~better~~ enabled to take care of the needs of the community.

Number of Physicians.—It is difficult to state how many physicians will be required for an adequate health program. The size of the plant, hazards involved, labor turnover, the distance to a hospital, availability of physicians in the community, and other factors have to be taken into consideration. It is doubtful if, even in peacetime, many plants with less than one thousand employees can profitably afford the services of a full-time physician. In view of the shortage of physicians, few plants with less than two thousand employees, other than those engaged in the production of explosives or ammunition, will have a full-time physician.

It is a mistake to gauge the number of physicians or to base a medical program on the requirements of the explosives industry. Because the hazards are not comparable to other war industries, more physicians will be required not only to prevent occupational diseases, but to be available for major catastrophes rarely encountered in industries engaged, for example, in ship-building or machining operations. In the explosives industry, the number of physicians will be 1:1000 to 1:2000, depending on the size of the plant.

In other war industries, one physician, by conserving his time, may serve as many as 5000 to 7000 employees or even more. It would seem advisable, however, for the ratio of physicians to employees not to exceed 1:4000, especially if the plant covers many acres, and there are a number of substations of the infirmary. The services of the medical director should be augmented by other physicians, some of whom will probably be on a part-time basis.

Qualifications.—Personal and professional standards requisite to the successful practice of industrial medicine and surgery have been set forth in clear detail by the American College of Surgeons.² Concerning the qualifications of an industrial physician, it states:

1. He should be a graduate of an accredited medical school and licensed to practice in the State or province.
2. He should have at least one year's internship in an accredited hospital.
3. He should have some experience in general practice, either prior to or supplemental to his duties at the plant.
4. He should have a general knowledge of industrial relations, including employment methods and problems, transportation, housing, recreation, educational facilities and methods, and employees' benefit plans.
5. He should be qualified to determine by examination of employees their physical and mental fitness for work.

6. He should have a knowledge of the ingredients and of the toxic or disease-producing qualities of the materials and processes used in the industrial organization which he serves.
7. He should have a knowledge of sanitation, of working conditions, of accident and occupational disease prevention methods, and of preventive health measures in general.
8. He should have a knowledge of the diagnosis and treatment of occupational diseases.
9. He should be competent in the diagnosis and handling of all traumatic lesions which he undertakes to treat.
10. He should be versed in the procedure for follow-up and rehabilitation.
11. He should have a knowledge of workmen's compensation laws.
12. He should have a knowledge of an efficient record system and of statistical methods.
13. He should have an unbiased industrial viewpoint and a confidence-inspiring personality.
14. He should realize that his first duty should always be to the workman whom he examines and treats.
15. He should like people.

While it is probably too much to expect the new industrial physician, even though in some instances he be the medical director, to possess all of these attributes at first, it is essential that he have breadth of vision and receptivity of mind sufficient to attain them. Concerning the characteristics that stamp his value as a man, particularly the insistence on his liking people, there should be no compromise. The medical program had better be left undone than conducted by inept or unamiable physicians.

Consultants

The standard for obtaining consultants can be summarized tersely in the somewhat trite but nevertheless true expression, "Nothing comes cheap." The decision concerning when to call in a consultant and whom to call should be motivated by what is the best interest of the patient. The industrial physician who attempts to spread his professional capabilities too far is almost certain to come to grief. The business executive who encourages such actions under the guise of economy is likely to regret it.

Where specialists such as general surgeons, orthopedists, roentgenologists, oculists, or dermatologists are frequently utilized, they should be given recognition as members of the consultant staff; other specialists should be called in as may be indicated. In selecting consultants, especially for difficult cases or cases in which time loss may be reduced by obtaining the services of highly qualified experts, advantage should be taken of the marvels of modern rapid transportation. Why entrust a difficult

fracture case to the care of a local general surgeon when a competent orthopedic surgeon is available?

Dentists

Reference is made to the chapter on *Dental Services*, which describes the personnel required for an industrial dental program.

Nursing Supervisor

Although the qualifications and duties of the industrial nursing supervisor are covered in much greater detail in the chapter on *Nursing Services*, there are a number of features of particular interest to the medical director endeavoring to start an industrial health program.

Even though in a small plant less than half a dozen nurses are employed, one should be designated as supervisor and be given the responsibility of directing the activities of the nurses. She also should be made responsible for the appearance of and ordering supplies for the medical department.

Regardless of the size of the plant, extreme care should be exercised in appointing the nursing supervisor. In larger plants it is advisable that she have had training or experience in public health nursing. In smaller plants, while this may not be feasible, she should have an interest in public health nursing and a desire to cooperate with official and private public health agencies. A competent nursing supervisor is able in many ways to relieve the medical director of many details which need not even be brought to his attention. To insure harmonious relationships she should be given the responsibility of selecting members of the nursing staff, or at least should have a voice in their selection.

The attitude of the medical director toward the supervising nurse should be that of "Loyalty up begets loyalty down." The supervising nurse should have all necessary authority and support.

Nurses

The duties of nurses are also described in detail in the chapter on *Nursing Services*. In estimating the number of nurses, it should be borne in mind that on the basis of a 40-hour week, 4.2 nurses are required to fill a given position for a full 168-hour week, exclusive of absence on account of sickness or vacations. Even on the basis of a 48-hour week, 3.5 nurses will be required

for each position if the plant operates 24 hours a day, 7 days a week.

In planning an industrial health program, there should be no attempt to stint on the number of nurses. Wherever possible, their duties should be up-graded to relieve physicians of such responsibilities as may be safely entrusted to nurses. At the present time, although there is a shortage of nurses, this shortage is not so great as that of physicians, nor is it likely to become so acute. In the chapter on *Medical Services*, ways will be shown in which nurses may be utilized to better advantage.

There is a tendency in many plants to devote too much of the nurse's time to clerical duties. This results in paying a trained nurse to do the work of an untrained typist. A careful job analysis should be made to determine if the nurses are spending too much time keeping records and making reports, jobs which can be done more efficiently by other persons. In some instances greater efficiency may result by the replacement of nurses by typists and stenographers.

A word of caution seems in order against a plant denuding the community of its nursing supply. Because the pay is steady with opportunities for overtime work and the work pleasant, nurses often prefer service in industry to hospital service or private duty. In some localities, bitterness has developed because an industry has taken a disproportionate share of the available nurses. This can be prevented if the industry recognizes the shortsightedness of a policy which results in ample nursing services for workers at the plant but insufficient service when they or their families are hospitalized for what may be a more serious injury or illness. This situation can be largely prevented by recruiting nurses for industry from places not faced with an acute shortage. Local and State nursing associations should be able to be of assistance.

Nonprofessional Clinic Assistants

As the shortage of nurses becomes more serious, the services of nonprofessional workers will have to be used to a greater extent. These may be practical nurses with sufficient experience or recent graduates of courses in practical nursing. These assistants may be used satisfactorily in substations with rest rooms in which the duties are more like those of a matron than of a nurse, or to assist the nurses in the larger infirmaries. In no instance, however, should less qualified individuals be used to replace the

trained nurse in duties requiring the training and experience which may only be obtained in an accredited school of nursing.

First-Aid Men

Because of the prevailing high wage scale in industry, the first-aid man is likely to become more or less extinct, at least for the duration. With the acute shortage of labor there seems little excuse for able-bodied men doing this kind of work. The custom of having a first-aid man, usually a former pharmacist's mate in the Navy, do parts of the physical examination which should be entrusted to a physician cannot be too strongly condemned. This practice is almost certain to result in a lack of confidence in the medical department by the workers, plant officials, and the medical profession. Furthermore, legal difficulties may be involved

Laboratory Technicians

These are only required in the larger infirmaries. In the smaller ones, nurses may be trained to do the limited amount of laboratory work usually required. At the present time, well-trained technicians are extremely hard to obtain in many places. Fortunately, the amount of training necessary for most industrial laboratory work can be obtained in a relatively short time, and steps are being taken to reduce the shortage.

X-ray Technicians

These are more difficult to obtain and their training is more extensive. This factor should be considered before deciding to install X-ray equipment. All X-ray technicians should be graduates of an approved course and registered according to the laws of the State.

Physiotherapy Aides

Except in the largest plants, none will be needed. There is little physiotherapy which cannot be performed by a nurse, provided she is instructed in the avoidance of overtreatment.

Ambulance Men

Ambulance drivers should be instructed in first aid, particularly in preventing shock and hemorrhage and the proper handling of fractures or potential fractures.

Nutritionists

In the larger plants one or more nutritionists should be obtained to supervise the cafeteria, instruct employees in the principles of an adequate diet, and give special instruction to persons who are underweight, overweight, or who have other dietary problems. In the smaller plants nutritional supervision and instruction should devolve upon the chief nurse or one of her assistants.

RELATIONSHIP TO OTHER PLANT ACTIVITIES

To be of the greatest service to both management and labor, the medical director should cultivate the good will of heads of other departments, particularly those concerned with employee relations and welfare, and with employee organizations. The medical department should be viewed by all concerned as a "neutral zone," designed primarily to serve as a health agency within the plant, in which sound professional counsel may be obtained in an unbiased atmosphere. The medical department will succeed to the extent to which this ideal is attained. It is important that others understand what the medical department has to offer and that the medical department have an appreciation of the functions and pertinent problems of other activities in the plant.

Top Management

In many concerns, the president or general manager is keenly interested in the medical department and in the health and welfare of employees. In most cases this is not because of paternalistic motives but rather because of an intelligent appreciation of the fact that health and contentment are business assets. The newer type of business executive is more likely to be receptive to a health program developed along sound, progressive lines. The medical director should attempt to cultivate the friendship of top management in order to gain support for his program.

Personnel Department

The activities of the personnel department and the medical department are interrelated in so many ways that cooperation is essential if each is to function with a maximum efficiency. For example, the success of any system of sick absenteeism recording is dependent upon the support given it by the personnel department. On the other hand, the personnel department is dependent on the medical department for prompt reports regarding the out-

come of physical examinations and prognoses of injuries. Working arrangements should be made with the personnel department whereby the medical department will be permitted sufficient latitude in the selection of its personnel.

Safety Department

For some generally unexplained reason, friction is more likely to develop between the medical and safety departments than almost any other parts of a plant. Judged by any standards this is most regrettable. These two departments have so much in common and are interdependent to so great an extent that every effort should be made to develop harmonious relationships.

Most of the difficulties seem to stem from a feeling that each of these departments is attempting to invade the proper sphere of the other. The medical department should not be under the safety department, nor *vice versa*. Each has its function. The medical director should feel free to advise with the safety director concerning the prevention of injuries, while the safety director should not hesitate to inquire of the medical department concerning phases of injuries having a relationship to safety or to advise regarding conditions in the plant involving health or the prevention of occupational diseases. In some plants the medical director and the safety director make joint inspections, each attempting to be of assistance to the other.

Legal Department

Because of the frequency with which medical records are used in court cases, the medical department should obtain advice from the legal department concerning the adequacy of records, methods of identifying exhibits, the maintenance of files, and other features having a possible medicolegal significance. When in doubt, the medical director should obtain opinions about the legal responsibility of the company, and of members of the medical department regarding various procedures.

Labor Unions

Many a worthwhile health activity, such as a tuberculosis survey, has met with overwhelming opposition because the workers whom it was intended to serve were not properly informed. Labor has often looked askance at plant medical activities, and at times with just cause. Too often the medical director has earned for himself the title of "company doctor," with all of its

implications. The medical program has been regarded as paternalistic or as a mailed fist in a velvet glove designed to attain unpraiseworthy ends. This accounts for the opposition of labor to preplacement and especially to periodic examinations. These examinations have been alleged, apparently with some justification, to have been used as a method to exclude applicants or discharge employees undesirable because of their labor views or because of their age.

No plant medical program can afford to leave labor out of the picture. Many labor unions are becoming health conscious and are demanding a voice. The attitude of labor is not as a rule unreasonable if the program is explained in the proper light and if it feels that it is more than the recipient.

The medical director should explain his program to responsible labor union officers. Some form of health committee should be formed either on a union or shop basis, depending on local conditions. Matters pertaining to health should also be the subject of consideration by labor-management committees. In larger plants it is desirable to appoint a special subcommittee on health and safety. Among other things, this committee can be of assistance in resolving alleged discriminations because of physical examinations.

Insurance Department or Carriers

Friendly relations should be maintained with the insurance department if the company is self-insured, or with the representatives of an insurance carrier. Proper requests for information should be complied with promptly.

Welfare Department

Cooperation with this department should aid in obtaining prompt payment of sick benefits, special nursing services, and loans for temporary financial stringencies due to illness. There are many other ways in which such cooperation may be effected. Where the employees' counsellors are in this department, they should be consulted in matters of job placement, and should be encouraged to bring cases of illness, particularly emotional disorders, to the medical department.

Cafeteria

The medical department should be responsible for the sanitation of the cafeteria. The medical director should determine

that well-balanced, nutritious meals are provided at reasonable cost, and that employees be informed concerning the requirements of a balanced diet so that they may order food intelligently.

RELATIONSHIP TO OUTSIDE AGENCIES

Local Health Department

Friendly relations should be established with local health facilities during the first stages of construction. In an existing plant a new medical director should become acquainted with the local health officer on arrival. If there is no well-organized health department the plant should get in touch with the State health department and with the District Office of the U. S. Public Health Service to have these facilities furnished.

The medical director should obtain information concerning regulations governing the reporting and control of communicable diseases, tuberculosis control, venereal disease control, milk and food inspection, school medical services, vital statistics, and other functions of the local health department. He should learn what industrial hygiene services and laboratory facilities are available at local levels.

Coroner's or Medical Examiner's Office

To prevent misunderstandings in sudden or unexplained deaths, particularly if the plant is located on a government reservation, its legal status with regard to coroners' inquests or medical examiners' investigations should be determined in advance.

State Health Department

To determine what facilities are available, contact should be made with the State health department, particularly the industrial hygiene unit, the laboratory, the sanitary engineering unit, and the division of communicable disease control. Should the plant be located on a government reservation, difficulty may be encountered in obtaining permission for State health officials to participate as actively as in the instance of private concerns. Insofar as is practicable, arrangements should be made for responsible State officials to visit the plant in the performance of their usual duties. There has been a regrettable tendency at some plants to by-pass local and State health officers. It is well to bear in mind that the workers are citizens of the States in which the

plants are located and that they have been accustomed to look to State and local officials for health protection. Furthermore, after the war emergency has passed, the health of these citizens will continue to be the responsibility of these officials.

The plant medical department should depend upon State laboratories for laboratory work wherever possible, and should use its influence in having these services augmented to provide for the additional burden incident to the war. As has been previously indicated, it is generally unwise for a plant to attempt to perform serodiagnostics tests for syphilis. Even where they are done, arrangements should be made with the State for periodic checks to determine the accuracy of the results of the plant laboratory.

Whether reported to local or State officials, the medical department should be meticulous in furnishing prompt and accurate reports of tuberculosis, venereal diseases, and acute communicable diseases. State officials should be invited to investigate outbreaks of food poisoning, or of water-borne epidemics.

With the exception of military and naval industrial establishments located on Federal property, industrial hygiene problems should be first reported to the State industrial hygiene unit which is available and ready to furnish advice, consultation, and engineering studies. Industrial hygiene problems arising in military or naval industrial establishments should be reported through proper channels to the industrial hygiene sections of the Surgeon General's Office of the Army or Navy, to the Ordnance Department, or to the Division of Industrial Hygiene of the National Institute of Health. As the responsibility for these measures is constantly changing, the medical director should keep currently informed as to the proper procedure.

U. S. Public Health Service

The Division of Industrial Hygiene of the National Institute of Health is available for laboratory studies and advice on the toxicity of substances employed in war industries. Its corps of research workers is engaged in investigating problems arising out of the current emergency. A mass of literature has been developed which is often of considerable assistance in determining the control of industrial hazards. Experienced physicians and industrial hygiene engineers have been assigned to State units and to mobile teams for special studies. The District Offices of the Public Health Service are available for advice on matters pertaining to sanitation, housing facilities, and the medical care

of the civilian population. Problems relating to mosquito control should be reported to the Public Health Service through the District Offices.

Office of Civilian Defense

The Office of Civilian Defense is responsible for measures to protect the civilian population against enemy action. Medical officers of the Public Health Service are assigned to the Office of Civilian Defense to supervise arrangements for the care of the injured, emergency hospitalization, and other similar measures. There are branches of the Office of Civilian Defense in nearly every community, especially along the seaboard and in the Great Lakes area. Plant medical directors should obtain information from the local Office of Civilian Defense about its program in event of an air raid or other enemy action. The infirmary, substations, and ambulances should be suitably equipped to function in blackouts. The medical director should be informed of local arrangements for hospitalization in case of this type of emergency.

Other Federal Agencies

The Defense Health and Welfare Services of the Federal Security Agency, and the Federal Public Housing Authority are available, through their district offices, for the purpose of augmenting community facilities and housing in war industry areas. The Fish and Wildlife Service of the Interior Department is responsible for the protection of streams against pollution inimical to fish and wildlife and for the maintenance of game sanctuaries. The Women's Bureau and the Children's Bureau, both of the Department of Labor, are responsible for problems arising from women and children in industry. Many other divisions of the Department of Labor are concerned with the health and welfare of employees. The Division of Labor Standards, in particular, is concerned with safety standards. Ex-servicemen requiring hospitalization should be referred to the Veterans Administration.

The medical director should maintain friendly relations with the branch of the Army or Navy with which his plant holds its contract. This particularly obtains when the plant is Government-owned but contract-operated. The medical department should be fully informed concerning the policies of the military authorities

concerning health, safety, and personnel relations, and should promptly furnish all necessary information to properly designated authorities.

Private Agencies

The medical director should acquaint himself with the aims and purposes of local agencies such as the Community Chest and the local U. S. O. He should affiliate himself with the local medical society, the Association of Industrial Physicians and Surgeons, and the American Public Health Association. To avail himself of their facilities, he should write to the National Tuberculosis Association, the Mental Hygiene Association, the Social Hygiene Association, and the other groups that are mentioned in Chapter 8. Although not concerned primarily with health, the National Safety Council is playing an important role in the war effort. Its excellent posters need no special endorsement.

The American College of Surgeons has developed standards for industrial medical service. These relate to professional qualifications, personnel, records, and equipment. Efforts should be made to comply with these standards.

Public Health Education

One of the chief reasons why plants do not engage in active health educational programs is that the medical directors often do not know where they can obtain the proper information. There are a number of sources which should be tapped for authentic health information prepared in an attractive and nontechnical manner. Many local and State health departments have health educational sections with information available on request. The Division of Industrial Hygiene of the National Institute of Health and the Division of Sanitary Reports and Statistics of the Public Health Service have developed brochures, posters, and motion pictures designed to inform the worker of the principles of proper living. Advice concerning nutritional education can be obtained from the Nutrition Section, Division of Chemotherapy, National Institute of Health, and from the Nutrition Section of the Office of Defense Health and Welfare Services. Large life insurance companies, the National Tuberculosis Association, the American Heart Association, the Woman's Field Army Against Cancer, and many other similar organizations can be utilized in health education.

CONCLUSIONS

To insure efficient and harmonious operations, the medical department should be made directly responsible to top management. The medical director should have ready access to the president or general manager. At the outset the duties of the medical department should be defined by competent authority. The medical department should be regarded as a highly important component whose function is to maintain the human element at its greatest efficiency.

Extreme care should be exercised in the selection of a medical director, who, in addition to being a competent physician, should have an interest in the type of work and be possessed of qualities of leadership and executive ability.

Even in a relatively small plant it is advisable to have a nursing supervisor. She should be made responsible for the selection, training, and assignment to duty of the nursing personnel. Caution is urged against denuding the community in which the plant is located of its supply of nurses. Such a policy is extremely short-sighted and besides incurring disfavor may result in increased time loss from nonoccupational diseases and injuries because of insufficient nursing services for the workers and their families.

The medical director and his assistants should make every reasonable effort to obtain the cooperation of top management, the personnel department, the safety department, and labor in the development of the medical program. They should be informed concerning the objectives of the medical program and their guidance sought in matters of concern to them. The desirability of bringing labor into the picture is reiterated.

Efforts should be made to ascertain what services are available from official and private health agencies, especially in the field of industrial hygiene. The medical department should cooperate with health authorities by the prompt reporting of communicable and other diseases.

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CHAPTER 4

MEDICAL SERVICES

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IN outlining a medical program for industry in time of war, the writer is torn between the extremes of the ideal and the practical. If he advocates all that may be accomplished in the direction of improving employee health, he can be justly accused of unrealism. If he stresses the probability that things will get worse because of shortages of personnel and equipment, he assumes a negative and defeatist attitude. Somewhere between these extremes lies the proper course.

NEED FOR A POSITIVE HEALTH PROGRAM

There has never been a time when an industrial health service could accomplish so much in the field of preventive medicine. Never in the history of the Nation has there been a greater necessity for keeping workers on the job every possible day. It is the duty and responsibility of the plant medical department to do everything within its legitimate sphere to reduce absenteeism due to illnesses and injuries among workers engaged in furthering the war effort, on the outcome of which the future peace and prosperity of this Nation depend.

The reiteration of the desirability that industrial medical services devote more of their activities in the direction of the prevention of disease may sound somewhat trite. In many plants the medical departments are firmly indoctrinated with this point of view. In others, unfortunately, there is a wide divergence between what is agreed to in principle and what is accomplished.

There has been too great a tendency for industrial hygiene physicians and engineers to gather at official conferences, association assemblies, and annual banquets of medical directors, and discourse at great length on what they are doing to protect the health of workers while in reality their programs fall far short of these objectives. Sometimes the impression is quite evident that these mutual admiration contests are a sort of defense mechanism for what is being left undone.

In too many plant medical departments, the primary and often the sole function is to provide reparative service for injuries, and the medical department owes its existence to the fact that the plant is a self-insurer. Although it can be shown that a medical department can usually provide more efficient treatment of injuries, it should not limit its activities to "finger-wrapping," either on a literal or figurative basis. Within certain limits, it can prove its greater value by expanding its activities to include the prevention of disease as well as the treatment of injuries.

The need for a progressive, broadened program is accentuated by conditions incident to the present emergency. In some instances neither local health departments nor private physicians are sufficient to carry the entire load. Medical departments, like soldiers on the field of battle, must be prepared to meet challenges in a manner "over and above the normal call of duty." At the same time, efforts should be made to winnow the wheat from the chaff, to curtail the nonessential, and to utilize existing personnel to the greatest advantage.

PREPLACEMENT PHYSICAL EXAMINATIONS

Need for More Liberal Attitude

The purpose of a preplacement physical examination should be to determine in what capacity the prospective employee can be utilized most efficiently without detriment to himself or his fellow workers. The emphasis should be on spreading employment to as many workers as possible rather than on exclusion. In the past, physical requirements have often been too exacting. Even in times of peace this resulted in many undue hardships and has been partially responsible for coolness, if not open opposition, on the part of organized labor toward industrial medical services. In times of national crisis it is essential that workers even with moderate physical handicaps be given employment wherever possible.

Physical standards should be based on the requirements of the job involved. For example, most persons free of mental disorders, active pulmonary tuberculosis, or severe visual defects are capable of performing clerical duties. The loss of a lower extremity, or the presence of hernia, moderate degree of heart disease, or diabetes mellitus under adequate control need not be a bar to employment. In sedentary occupations, in general, the

usual requirements are likely to be far less exacting than for the more strenuous jobs.

The unreasonable attitude toward arterial hypertension is a case in point. In the past there has been too great a tendency to set arbitrary standards. All persons with arterial blood pressure over 150 millimeters of mercury systolic pressure, or over 90 millimeters of mercury diastolic have often been declared ineligible for employment at a given plant, even though there was no evidence of cardiac insufficiency or other organic changes due to arterial hypertension. Save in infrequent instances, such as the jobs of crane operators, locomotive engineers, or other special occupations, most persons with moderate degrees of arterial hypertension should be regarded as employable. Similarly, most persons with inactive pulmonary tuberculosis, heart disease without cardiac insufficiency, diabetes mellitus, bronchial asthma, orthopedic defects, and many other conditions are fit for most jobs. *If the applicant is not fit for the job for which employment is sought, efforts should be made in the direction of job placement.*

Jobs Involving Exposure to Toxic Hazards

Workers exposed to toxic substances such as TNT, DNT, tetryl, fulminate of mercury, or lead azide should be subject to more rigid requirements than other workers. Efforts should be made to eliminate habitual users of alcohol, mouth breathers, those with marked dental defects, and particularly persons showing any indication of anemia, liver or kidney diseases, or chronic respiratory diseases. Persons undergoing treatment for syphilis should not be employed in toxic operations. Persons with skin diseases should not be exposed to substances known to cause occupational dermatoses.

Extent of Physical Examination

Because a liberal policy is advocated in the matter of spreading employment, this should not be interpreted as condoning laxity or slipshod preemployment physical examinations. There is probably no other criterion as reliable in determining the efficiency of a medical department as the thoroughness with which it performs these examinations.

In the opinion of the writer, too much emphasis should not be placed on the previous or present medical history during a preemployment physical examination. After all, the applicant is seeking a chance to earn a livelihood and is likely to stand

on his constitutional rights and admit little or nothing that may incriminate or, to be more exact, jeopardize himself. Consequently, negative information is of little value. On the other hand, it is often possible to obtain certain positive information which may be of value. Suggestions concerning the personal history are included in the section on medical records, which follows.

The physical examination should include a careful physical inspection of the skin and mucous membranes, the eyes, ears, nose, and throat, inspection and palpation of the thyroid gland and vessels of the neck, auscultation of the lungs if an X-ray is not obtained, palpation and auscultation of the heart with particular reference to the position of the apex beat, palpation of the abdomen, inspection of inguinal rings, careful scrutiny of the genitalia, rectal examination dependent on the extent of apparent involvement, inspection of the bony framework and joints, and such a neurological examination as may be indicated. The examination should also include a pulse rate and blood pressure determination, serodiagnostic test for syphilis, and urinalysis which should include an examination for glucose and albumin, and such microscopic examinations as may be indicated. Where possible, a roentgenologic examination of the chest should be made.

Streamlining the Physical Examination

Under normal circumstances the physical examination should be conducted in the privacy of the physician's office. Owing to the shortage of physicians and the large number of applicants who have to be "processed" in a relatively short period, it is necessary to devise methods whereby the physician's time may be rationed intelligently, and at the same time the quality of the physical examination should not be permitted to deteriorate. As the shortage of physicians is almost certain to become even more acute, greater attention should be given ways and means for making preplacement examinations more efficient.

With the cooperation of management, efforts should be made to build up a pool of prospective employees before production is begun. This will enable the medical department to examine them with greater care than if perhaps several thousand are examined during the space of a few weeks. It is also possible to find positions for handicapped persons and others with physical defects. Besides being of help to the medical department, it enables the plant security department to investigate more thoroughly appli-

cants for the purpose of preventing the employment of persons likely to become involved in subversive activities.

Every effort should be made to relieve physicians of as many details as possible in connection with the physical examination. Blood for serodiagnostics and other tests should be obtained by nurses or technicians, urine specimens obtained while waiting for the physician, and the blood pressure, pulse, weight, height, visual, and hearing examinations should be made by nurses or other qualified assistants. A chest X-ray generally obviates the necessity of auscultating the lungs during a routine preemployment examination and often gives clues to the size of the heart.

Given this much of a running start, the physician can complete the physical examination in less than five minutes with a reasonable degree of accuracy, particularly if clerical help is provided. If the examinations are performed in the physician's office, a male clerk or a female clerk behind a screen may be employed. This part of the examination may be even more streamlined by examining a number of applicants, perhaps as many as 10 or 12 at one time, the physician calling out positive findings to a male clerk.

Examination of Women Applicants

The examination of women applicants should be done with a thoroughness equal to that of men. In addition to the usual history, inquiries should be made about menstrual disturbances and histories of pregnancies. Women should be shown the respect of having the examination performed in the physician's office or elsewhere in private in the presence of a nurse or other female attendant. It may be necessary to provide cubicles or disrobing booths to insure privacy and reasonable rapidity.

In preemployment physical examinations, pelvic examinations should be required only on infrequent occasions based on special indications. It is quite easy for a plant medical department to create many embarrassing situations by such examinations. Before making them, the medical department should obtain authoritative information concerning the legal status of such examinations in the State in which the plant is located. The routine obtaining of vaginal or cervical smears is mentioned only in condemnation. Even when cultures are obtained the percentage of positive cases is so small as not to warrant routine examination:

Examination of Construction Workers

Construction workers are generally hired for relatively short periods of time and often change employment at frequent intervals. To a certain extent they may be regarded as free agents selling their services where needed. Physical examinations of these transient workers can be overdone, especially during this emergency when it is necessary to utilize workers with minor or even moderate degrees of physical impairments. Also, when a construction job is begun, time is at a premium. It often becomes necessary to examine a considerable number of workers in a short period. Furthermore, these workers have often been examined a few months or weeks previously at a former place of employment.

The objective of such a preplacement examination should be the detection of defects which might cause them to be a hazard to themselves or their fellow workers or which might result in the payment of claims for disability. This examination, in view of the shortage of medical personnel, must of necessity often be considerably abbreviated. The personal history can often be omitted or reduced to a brief statement of illnesses and injuries during the past few years. The physical examination should consist of an appraisal of factors likely to impair usefulness for the job involved. These include examinations for vision, blood pressure, heart, hernia, and musculo-skeletal defects. Where possible a photofluorographic chest X-ray and test for syphilis should be included. If a construction worker is retained for permanent employment, he should have a complete physical examination.

Informing Applicants of Physical Defects

One of the criticisms directed at preemployment physical examinations by organized labor is that applicants are not informed concerning causes for rejection or about physical defects which should be corrected. In the mind of labor such an examination is quite one-sided. This criticism is not without merit. Regardless of the desirability for speed in examining large numbers of applicants, the physician should take the time personally to inform the rejected applicant of the cause for his rejection. Accepted applicants should be informed of physical defects, particularly if they may be corrected. The physician, if possible, should inform them concerning the more serious defects with a view to facilitating corrective measures, while employees can be

informed of less important defects by the nurses who should exert influence toward having them corrected.

Persons found to have venereal diseases should be informed by the physician who should explain the policy of the medical department with regard to these diseases. Having expressed an interest in the employee's welfare, the physician can then find out if treatment has been started. If not, the physician can advise about local private or public facilities. See chapter on *Venereal Disease Control*.

Plant physicians by their manner and their interest in prospective employees' welfare during the preplacement examination have an opportunity to gain the workers' confidence. If the worker looks upon the physician as an interested friend, if he feels that the medical department is a "neutral zone" in which his confidences will be respected, he will avail himself of the opportunity to discuss his health problems with the plant physician. This will redound to the greater efficiency of the medical department which can only attain its greatest usefulness by winning the confidence of both management and labor.

PERIODIC PHYSICAL EXAMINATIONS

Annual Physical Examinations

Under normal conditions each employee should have a health audit, preferably once a year. Some plants limit these examinations to employees past the age of 40. Other plants find that by examining workers returning from illness, approximately 80 per cent of their employees are examined during the course of the year. These examinations are used in lieu of examinations at stated periods. This plan has the advantage of examining an employee at a time when he is more likely to be interested in his health than simply by appointment. The remaining 20 per cent who have not been absent on account of illness are examined by appointment.

Owing to rapid expansion of personnel, many plants have had to forego their program of annual or other periodic physical examinations. Efforts should be made to continue to examine key employees, especially persons past the age of 40, and others who may be carrying more than their normal share of responsibility. This should not be limited necessarily to the top-flight executives, as important as it is to maintain their health.

Examination of Workers Exposed to Toxic Substances

This discussion is particularly applicable to the explosives industry, either manufacturing or the filling and assembly of projectiles, bombs, or their components. Other war industries have workers who are exposed to lead, mercury, silica, benzene, solvent vapors, metallic fumes, dermatitis producers, and other substances whose control should include physical examinations of exposed persons at periodic intervals. It should be emphasized that the physical examination should be used in conjunction with engineering methods of control, never in lieu of a proper working environment. In the prevention of occupational disease the physician and the engineer must work side by side to attain the proper results.

To prevent occupational disease the plant physician should have a working knowledge of the industrial processes involved, the number of workers exposed, and the degree of exposure. He should inform himself with regard to the maximum permissible concentrations and know under what circumstances and in what places the maximum allowable concentrations may be exceeded. He should make frequent inspections of the workrooms and of the change houses, and should determine the adequacy and efficiency of the shower baths. It is essential that he have a thorough insight into the clinical manifestations of occupational diseases to which workers under his supervision may become exposed. He should know the prodromal as well as the full-blown manifestations of these conditions.

These periodic examinations should include a brief but pertinent history, physical inspection, weight, pulse rate, blood pressure, and, in some instances, a urinalysis and a hemoglobin determination. Excellent results have been obtained by the use of hemoglobinometers based on the principle of the photoelectric cell. These examinations should be performed in the change houses or first-aid rooms in such a manner as to reduce to a minimum the amount of time lost from work.

Nurses in Preliminary Examinations.—In view of the shortage of physicians, nurses should be trained to make preliminary examinations for the purpose of screening suggestive cases for examination by the physician. Under such a plan the nurse would make an examination as indicated above, and the physician would review those cases with histories or physical findings suggesting occupational diseases.

Examination at Frequent Intervals.—In the prevention of occupational dermatoses it may be necessary to examine the employees at weekly intervals, or more often, especially when dealing with tetryl. Here again the nurse can be trained to assume the role of first line of defense. It will probably be impossible for the physician to examine each employee as often as may be required. Employees, however, should be directed to report to the nurse at the nearest first-aid station if they begin to develop skin manifestations.

Exposure to Specific Substances.—Workers exposed to TNT, DNT, tetryl, ammonium picrate, mercury fulminate, lead azide, lead sulphocyanate, and lead styphnate, carbon tetrachloride, benzene, toluene, or molten lead should be examined, at the beginning of operations, every three to four weeks. In some instances because of exposure to only small quantities of these substances, or on account of good engineering methods of control, it may be found unnecessary to examine them with that degree of frequency. Most places dealing with DNT and TNT have found it necessary to continue examinations at three or four weekly intervals. Tetryl, which is the most frequent producer of dermatitis, requires continuous supervision. Other workers, such as operators in ether-alcohol houses or persons engaged in mercury cracking tests of cartridge cases, require physical examinations every three months. Workers exposed to lead extrusion processes in which the danger of lead poisoning is less than from lead fumes should be examined about every six months. Workers exposed to extremely toxic substances such as tetraethyl lead may require examinations even more often than once a month. Workers exposed to dust hazards should be examined by means of a chest X-ray annually. Radium dial workers should be examined every six months; this examination should include X-ray studies of the jaw, chest, and long bones.

Key Workers.—In addition to these workers exposed to toxic substances, certain key workers should be examined periodically. These workers include crane operators, firemen, guards, railroad engineers, stationary engineers, ammunition truck drivers, and others whose sudden illness or death might result in a major accident involving the safety of other workers and the loss of valuable government equipment. These examinations, in which special attention should be paid the cardiovascular system, should be made semi-annually.

OTHER EXAMINATIONS OF EMPLOYEES

Physical Examination after Illness

Because of the shortage of physicians and the pressure of production, it is doubtful if it is feasible to examine physically every employee who has been absent from work on account of illness. They should be required to obtain a clearance through the medical department, and the nurse should obtain a record of the cause of illness. He should be examined by a physician if the illness is over a designated number of days' duration (usually three or seven days), if he is still having a fever, if the illness has apparently been due to a communicable disease, or if he appears too weak to resume work.

The objection may be raised that this leaves too much to the discretion of a nurse. As a matter of fact, it would be almost impossible to have a physician examine each employee who has been absent in a plant covering many acres or square miles, and which is operating three shifts a day. In times of emergency, more responsibility should be given the nurses.

One of the chief practical values of sick absenteeism records is that they enable the plant physicians to examine employees with poor attendance records to determine the causes of absenteeism with a view to correcting them. Here the industrial hygiene nurse or the visiting nurse can be of considerable assistance in determining the validity of alleged causes of absenteeism.

This raises the point about the attitude of the medical department to malingering, either due to feigned illnesses or injuries, or attempts to exaggerate existing injuries. Insofar as possible the medical department should assume the role of neutral arbiter. It should not exist primarily for the purpose of serving as a sort of truant system; neither should it condone flagrant malingering. It has a responsibility both to the employee and to the firm.

Transfer Examinations

Many concerns have the policy of physically examining employees on transfer or promotion. Where the transfers involve changes in exposure to a deleterious substance, or there is a history of injury on the previous job, such a physical examination would seem indicated. As a war measure it may be necessary to dispense with this examination unless there is a special indication.

Examinations by Request

The purpose of the medical department is to serve the plant and the employees. It will be requested by the workers for examination and advice concerning many conditions not directly due to their occupations. Unless such requests become unreasonable or tend to conflict too greatly with the private practice of medicine, efforts should be made to comply with such requests. As more family physicians are called to the colors, the scope of the activities of the industrial physician will perforce be increased. In some instances, for example, the plant medical department, being the only available source, should perform X-ray examinations and other services for the employees and their families either gratis or for a nominal charge.

Supervisors not infrequently request that a worker be examined either to detect communicable disease or to determine his fitness for work. Such examinations should be performed, but every effort should be made to respect the right of the employee with regard to professional confidences.

Termination Examinations

It is the practice of some industrial establishments to examine a person at the time of discharge to determine if he has developed an injury or occupational disease while working for them. Such a practice has merit in instances where persons are exposed to dust or toxic chemical substances, or where there is a history of injury. As a routine measure it may have to be dispensed with for the "duration."

EXAMINATION OF FOOD HANDLERS

There is hardly a topic in the field of preventive medicine in which there has been so much loose thinking as in the matter of examining food handlers. It ranges from no examination, or an almost equally useless perfunctory inspection, to complete physical examinations every thirty days.

Overemphasis on Venereal Infection

Too much emphasis has been placed on detecting venereal diseases among food handlers, as though venereal diseases were spread by these people in their capacity as food handlers. There is no gainsaying that as a class waitresses and other food handlers have extremely high rates of venereal infection. Persons with open venereal lesions, just as persons with other communi-

cable diseases, should be temporarily excluded from work. There should, however, be no discrimination against persons serving as food handlers solely on the basis of their having a positive serodiagnostic test for syphilis.

Examination for Specific Diseases

The applicant for a job as food handler should be examined initially and periodically by the plant medical department even though the cafeteria be operated on a concession basis. This examination should be similar to that for other employees and should include a serodiagnostic test for syphilis and a chest X-ray. If there is a history suggestive of typhoid fever, paratyphoid fever, or dysentery, an appropriate stool culture should be obtained. If the history suggests previous typhoid fever, a gallbladder drainage culture is indicated. If previous amebic dysentery is suggested, a proctoscopic examination should be included. All food handlers should be immunized against typhoid fever, paratyphoid fever, and smallpox.

Upper Respiratory Diseases

The chief danger from food handlers, aside from the enteric diseases mentioned previously, is through the introduction of acute upper respiratory diseases, especially streptococcic sore throat. To guard against these diseases, greater emphasis should be placed on excluding food handlers with these diseases rather than on examination at stated intervals. Even on the basis of monthly examinations, epidemics of these diseases can be introduced during the intervening period. It is urged that greater reliance be placed on examining and excluding food handlers with communicable disease. This can be done by requiring that they obtain a clearance from the medical department if they become sick on duty, and be required to obtain permission from the medical department before returning to duty after absence on account of illness. The cafeteria management should cooperate by requiring personnel with respiratory and other infectious diseases to remain at home.

IMMUNIZATIONS

Based on trends prior to the attack on Pearl Harbor, the National Resources Planning Board estimated that by the end of 1943, over 27,000,000 persons in this country will have undergone an economic dislocation. With this social and economic uprooting and relocating of nearly 30,000,000 persons, the danger of serious

epidemics will be greatly increased if vigorous measures are not adopted to prevent them. This calls for an augmentation of local health services, and the development of proper sanitary facilities, as well as other measures designed to reduce the likelihood of serious epidemics.

Although many of these measures will devolve upon local health officers, plant medical departments have a responsibility in the prevention of disease among employees. In the past, industrial medical services have often refrained from immunization programs on the ground that an unfavorable reaction might result in financial responsibility, either for the concern or its insurance carrier.

This is war! In the midst of a national crisis there is no time for quibbling over minutiae. Applicants who cannot show that they have been vaccinated against smallpox during the past year should be immunized against this disease. This procedure should be done as a routine measure with the least possible fanfare. It can be done expeditiously and with a minimum of inconvenience at the time when blood is drawn for a serodiagnostic test. At the same time, the first inoculation against typhoid fever can be administered.

In previously existing plants immunizations should be staggered so as not to interfere with production to any great extent. In plants located in large cities whose community facilities such as water, sewage, and milk inspection are well developed, it may not be necessary to immunize against typhoid fever and the paratyphoid fevers. In war plants located in rural areas in which employees are living in trailers and under other unsatisfactory conditions, they should be immunized against these diseases. To insure against outbreaks of these diseases among the civilian population, plant officials and the medical department should enlist the cooperation of local health officials in immunization programs among other members of the population.

RECORDS

The records of the medical department should be retained in the medical department and kept in such a manner that the confidence of the employee is respected. Statements to other departments should be couched in general phrases, and except for injuries and occupational diseases, diagnostic expressions should not be included in oral or written communications to other departments or persons.

A cumulative health record should be maintained on each employee. This should include the history and physical examination obtained on employment, laboratory studies including X-ray findings, and the results of periodic physical examinations. At the end of employment a terminal examination is often desirable. For the sake of convenience and in event the records are subpoenaed for court action, it is desirable that they be kept in a folder in such a manner as to insure against parts of the record being lost.

Form of the Record

The form of the record is of less importance than the accuracy of the information and its accessibility. One of the most satisfactory records is that of the Chrysler Corporation which combines a record with a folder in such a manner as to reduce the likelihood of pertinent data becoming misplaced. In planning a record, consideration should be given the rapidity of labor turnover. In plants employing persons for periods of short duration, such as construction companies, the record need not be extensive nor a folder prepared. Where employees are hired on a more or less permanent basis, a folder should be provided and provision made for periodic examinations. Where workmen are examined periodically because of exposure to toxic substances, records should be filed in such a manner that they may be taken to the change houses or first-aid stations where these examinations are conducted. In some plants the records are retained at the first-aid stations so that minor injuries treated by the nurses may be entered on the records. In event of a more serious injury requiring a visit to the plant infirmary the record is transferred.

Preplacement Examination Forms

Preplacement examination records tend to err in the direction of either asking irrelevant questions concerning an applicant's past history, or in assuming that because the person is seeking a job the past history will be of practically no value. Many physicians totally disregard the past history even if obtained. The proper appraisal seems to be that a negative history may often be erroneous, while a positive history of previous disease may be of considerable value. It should be borne in mind that a worker seeking a job is not likely to furnish information prejudicial to his interest and also that many persons simply do not remember previous illnesses.

The past history should be brief and pertinent. It should consist of a statement signed by the applicant about diseases or injuries during the past five years, and specific questions about surgical operations, epilepsy, nervous breakdowns, tuberculosis, rheumatic fever, diabetes, kidney disease, syphilis, gonorrhea, malaria, and typhoid fever. Inquiries concerning family and marital histories are usually irrelevant and may be omitted. In the case of females, inquiry should be made concerning menstrual disorders and complications of pregnancy. Here again, it is doubtful if much information of practical value will be obtained.

An inquiry should be made with regard to previous immunizations against smallpox and typhoid fever.

The extent to which inquiries are made concerning previous employment should be dependent on the nature of the work and to a certain extent on the locality of the plant. Inquiry should be made concerning history of exposure to dusts, lead, and chemical irritants, and a previous history of occupational dermatitis, particularly if the industry employing the worker has similar exposures.

The section concerned with the physical examination should be so arranged that the height, weight, pulse, temperature, blood pressure, and tests for visual and auditory acuity may be performed by a nurse and recorded conveniently. The remainder of the examination form should include appropriate designations of parts and organs of the body to be examined, with sufficient space for elaboration.

Periodic Examination Forms

The examination form for annual health surveys or examinations after illness should be similar to the preplacement examination form. Many firms provide additional columns so that a number of examinations may be recorded on the same form.

Exposure to Toxic Substances.—For the sake of comparison and in order to have a cumulative record in which the results of a number of examinations are readily apparent, the examination form for recording periodic examinations of workers exposed to toxic substances should be so arranged that a number of periodic examinations can be recorded, preferably in columns on a single sheet of fairly heavy, substantial cardboard or similar material. As the purpose of this examination is to detect illness due to a specific toxic substance, it should not be confused with a periodic health survey. Since it is necessary to examine a large number

of persons often at frequent intervals, the form should be devised to facilitate these examinations which should be made as rapidly as is consistent with accuracy. The form should contain a history and physical findings pertinent with the exposure involved. For example, if a worker is exposed to TNT, the history should contain inquiries about fatigue, insomnia, loss of appetite, indigestion, precordial or substernal distress, cough, and urinary disturbances. The physical examination should include references to weight, blood pressure, pulse rate, skin, hair, mucous membranes, and additional space for other positive findings. Should a more thorough examination be indicated, the form for annual or other periodic examinations may be used.

THE SMALL PLANT

Among the many unsolved problems in industrial medicine is that of furnishing adequate protection for the employees of small plants. Plants with less than a thousand employees are often unable to supply adequate medical facilities at a cost which they regard as within their means. Certainly few of them can afford to employ a full-time physician; in some of the smaller plants it is not even feasible to employ a nurse on a full-time basis.

Ideally, it would be advantageous for a number of these plants to obtain the services of a physician, each paying a prorated amount. The shortage of physicians and the location of these plants in isolated places militate against such a program during the present emergency. Industrial hygiene clinics, offered as a suggestion, are only available in a few places.

It is doubtful if any plan could be developed which would be universally applicable to this group of plants, which, although individually small, are destined to play an important role in the war effort. The following suggestions are made with a hope that some of them may serve as a guide in solving this problem:

1. Combine resources where possible.
2. Utilize industrial hygiene clinics of good repute.
3. Seek advice of the State division of industrial hygiene in planning program, and in identifying and controlling occupational hazards.
4. Obtain the services of a visiting nurse if plant is too small to justify a full-time nursing program.
5. Even though the physician is part-time he should develop an interest in the preventive aspects of industrial medicine and in employee welfare. To this end the employ-

ment of physicians on an "on call" fee basis should be discouraged.

SPECIAL FEATURES

Tuberculosis

From a practical point of view early tuberculosis can only be detected by an X-ray examination. The results of examination of college students indicate that tuberculosis can be detected ten times more frequently and at an earlier stage by an X-ray examination than by even a careful conventional physical examination. At the Eastman Kodak Company the incidence of tuberculosis has been reduced from 2.3 per cent to 0.2 per cent over a period of 20 years, during 12 years of which the company has had an active program consisting of chest X-rays on employment and at yearly intervals.

Most physical examinations in war industries are made under unfavorable circumstances. There is often a maximum of distraction and a minimum of concentration. It is difficult for even the most pathological set of lungs to compete with modern industry. Consequently, auscultation is reduced to little more than a perfunctory and ritualistic laying on of the stethoscope. It is therefore urged that X-rays of the chest be obtained wherever practical.

The other important feature of tuberculosis in the pre-employment examination is the matter of employing persons with previously known tuberculosis. According to Sawyer,¹ the following factors must be taken into consideration in the employment of an arrested case of tuberculosis:

1. The extent of the lesion.
2. The completeness of cure.
3. The character of the job.
4. The necessity for adequate medical supervision after return to work.

Given proper medical supervision, many persons who have had minimal or moderately advanced tuberculosis can become self-supporting workers.

Other features of tuberculosis in industry are discussed in the chapter on the *Medical Control of Respiratory Diseases*.

Heart Disease

In the hurly-burly of the average industrial physical examination, many cases of heart disease, even valvular disease, are

probably missed. Ideally, each applicant should be examined in the standing position with emphasis upon palpation of the apex to determine heart size and possible thrills. Auscultation should be made in the standing position and in the recumbent position, especially in the left lateral position after exercise. It is doubtful if it is practical to give each applicant so thorough an examination under the present emergency.

Valvular Disease.—Many more cases of valvular disease will be detected if greater attention is paid the size and contour of the heart as determined by X-ray and if more attention is paid to abnormal heart sounds, especially increased mitral first sounds or pulmonic second sounds, which, especially when accompanied by systolic murmurs, are often a tip-off of mitral valvular disease.

Persons with rheumatic valvular disease whose hearts are not enlarged and who do not have a history of recent rheumatic activity or of cardiac insufficiency, and whose rhythm does not indicate auricular fibrillation, may be accepted for occupations requiring moderate physical exertion. In deciding upon employing persons with congenital heart disease, special attention should be paid the degree of cyanosis and the size of the heart.

Syphilitic Aortitis.—Persons with syphilitic aortitis with or without aortic insufficiency whose hearts are not much enlarged and who have not had attacks of cardiac insufficiency may be accepted for jobs requiring moderate exertion, especially if they have had considerable treatment. Once these persons with cardiovascular syphilis have had attacks of congestive failure they are generally unemployable except in sedentary occupations. Unfortunately, many of them do not have educational qualifications for this type of work.

Arterial Hypertension.—Some type of job can be found for nearly every person with asymptomatic arterial hypertension. The problem is largely one of placement rather than exclusion. To assume that every person with a systolic blood pressure of as high as 200 mm. or more of mercury or a diastolic even as high as 120 mm. is unemployable will result in wastage of many man-years. Many of these persons carry elevated arterial blood pressures for a number of years and possess capabilities which should be utilized. Care should be exercised in placing persons with considerably enlarged hearts, histories of congestive failure, or coronary insufficiency (angina pectoris or coronary occlusion), personality difficulties, and organic peripheral vascular and central nervous system disease. Persons with severe hypertension

should not be given positions where a cerebral or cardiac episode might endanger the lives of others, or valuable property.

Coronary Disease.—Persons with evidence of mild to moderate coronary artery disease or with histories of a previous coronary occlusion may be employed in occupations which are not likely to aggravate these conditions. Because of the medico-legal aspects, care should be exercised in not placing these persons in positions where in event of a future attack it may be claimed that the attack was precipitated by conditions of employment. It should be borne in mind, however, that there are several hundred thousand coronary attacks each year in the United States. In view of the shortage of younger workers and the aging of the population, these persons should be given jobs to the extent of their physical capabilities.

Vision

Proper vision is essential to the efficiency and well-being of the worker in all his relations to his work. *The eye examination should be made with a precision based on the requirements of the job.* Concerning these standards, Snell² states:

Good vision is that degree of visual functional ability which is adequate to perform the usual tasks presented.

By this definition vision may be good when acuity is less than 20/20. Standards for normal ocular muscle balance, depth perception, fusion ability, and color perception have not been so rigid. Thus I have laid the emphasis on a misconception of the functional value of the acuity standard. It is on this expression of perfection of visual perception that placement personnel or management have been led astray. They are constantly basing their conception of an employee's visual ability on an expression of perfect visual perception, and only those who can show this degree of perfection are regarded as perfect for any job. It is important both from a social and an economic point of view to understand that the Snellen acuity of 20/20 is a standard of perfection but does not express the visual fitness of every visual task, and that employees may have "good vision" when acuity is less than this standard. A person with an acuity of at least 20/40 in one or in both eyes has adequate visual fitness for many jobs and often vision may be adequate with a lower acuity.

Incidence of Visual Defects.—Kuhn,³ in a survey of 16,332 industrial employees of several plants, found that acuity defects of 20/40 or less ranged from 15 to 38 per cent and that muscle imbalance, sufficient to interfere with comfortable and efficient vision, averaged 25 per cent. About 20 per cent of applicants have visual defects that are sufficiently high to handicap their efficiency. Defective color perception was noted in 5 per cent,

and impaired depth perception occurred in 5 per cent. The types of defects varied according to occupation and age.

Tests for Various Visual Tasks.—For most occupations, an examination with the Snellen chart will suffice. Truck drivers, locomotive engineers, and others guided by signals should be tested for color defects. Crane operators and others whose work requires discrimination at considerable distances should be given tests for stereopsis. Persons engaged in fine work at near distances, such as the assembly of certain fuzes, require tests for near vision. The important thing to bear in mind is that different jobs require different visual standards. It may be necessary in some cases to fit the worker with corrective lenses for the job involved; glasses for reading or for other ordinary use may not suffice.

Binocular Test.—Where greater than normal vision is required or some special problem exists, a binocular test or its equivalent should be employed in lieu of the Snellen test. This will provide a satisfactory appraisal of muscular balance, depth perception, and color vision. The binocular test is also of value in detecting malingering or persons with poor vision attempting to pass these tests.

Cooperation in Program.—A successful program requires co-operation among management, employees, medical departments, ophthalmologists, and opticians. The greatest difficulty in a program involving the eyes in industry is how to furnish the necessary corrections in an economical manner. Neither the industry nor its employees can afford to pay for mass corrections at the usual rates; nor can ophthalmologists devote much of their time to industrial practice except as consultants engaged for the treatment of industrial injuries and to assist in arranging adequate protective programs.

Role of Optometrists.—In some war industries optometrists visit the plant and make refractions, especially where corrections are provided for safety glasses or goggles. Because of the shortage of physicians on account of the war, it will probably become necessary to bring optometrists into the picture to a greater extent. To insure satisfactory work and to prevent misunderstandings, joint committees of plant physicians, ophthalmologists, and optometrists should be formed to consider the roles of each of these groups in sight conservation.

Illumination.—The plant physician should be conversant with the principles of good illumination and should have an apprecia-

tion of its importance in sight conservation, employee welfare, and increased production. The details of an illumination survey are the sphere of the engineer. The State industrial hygiene department can be of assistance in determining proper standards of illumination. See chapter on *Illumination, Noise, and Radiant Energy*.

Hearing

The industrial physician should bear in mind that certain occupations in war industries result in a definite impairment of hearing. Shipbuilding, test-firing of various size guns, work on test blocks of motors, and certain other occupations involve these hazards. Insofar as practical, efforts should be made to control these hazards by engineering methods based on acoustical treatment of walls and ceilings. If this cannot be accomplished suitable ear plugs may be used. Petrolatum-cotton packs are stated to be effective, particularly for high tones.⁴

Psychiatric and Emotional Problems

The industrial physician should strive toward the ideal that each physician should be his own psychiatrist. This does not infer that the industrial physician should possess a detailed knowledge of psychiatry but rather that he should have a working knowledge of the practical aspects of psychiatry, an understanding of the more common psychiatric and emotional disorders, and a deep appreciation of human nature. His approach should be more common sense than formal. Most of all he should avoid giving the workers the impression that they are being "psyched." If word gets around that there is a "nut doctor" on the staff, workers will stay away from the infirmary rather than undergo the suspicion resulting from such a visit.

It is doubtful if many cases of mental abnormalities will be detected during the course of the preplacement examination. The obviously incompetent will often be weeded out at the personnel office. Most of the cases seen by the medical department will be referred by supervisors because of maladjustments. The nurses should be instructed in the elements of psychiatry in order to be able to screen out personality problems for further study by the physicians. The great bulk of the problems will consist of psychoneuroses, anxiety states, and other minor emotional disturbances. See chapter on *Industrial Psychiatry*.

TREATMENT

Industrial Injuries

Under normal circumstances the bulk of treatments consists in the repair of injuries incidental to employment. Despite safety precautions in most manufacturing plants these are fairly numerous, although often not serious. It should be emphasized that even the most trivial wound is expensive. Not only is time required for its treatment, but there are many hidden costs involved. These include time lost by other employees aiding the injured or just onlooking, wastage of materials, time spent in investigations, and many other factors. Consequently, it can be confidently stated that if provision is made for the care of the minor injury, the major injury will usually be well treated.

Many of the minor injuries are treated by nurses with varying degrees of supervision. Definite directions should be issued concerning the nurses' duties and the extent to which they may assume responsibilities. In foreign bodies on the conjunctiva, nurses should be limited to the treatment of those which are not imbedded and do not require the use of an instrument.

As indicated in a previous chapter the treatment of patients requiring hospitalization should usually be done in a general hospital. Aside from financial savings, treatment can usually be rendered more efficiently.

Occupational Diseases

The most frequent occupational diseases are the dermatoses, which as a rule are not incapacitating. Change from a given job may be required with prolonged medical supervision.

As with injuries, occupational diseases requiring hospitalization should generally be treated in a general hospital.

Nonoccupational Diseases and Injuries

Under normal circumstances a plant medical service should not invade the field of private practice by prolonged treatment of nonoccupational conditions. In most cases, even under present conditions, treatment of nonoccupational injuries or illnesses should be limited to that sufficient to keep the worker on the job until he sees his family physician. That, of course, presupposes that he has a family physician. For the duration of the war it may be necessary for industrial physicians to liberalize their conceptions of the extent to which diagnosis and treatment of non-occupational conditions will have to be made. In communities

where medical facilities are lacking, plant physicians will have to assume a greater share of the burden. It should also be borne in mind that practicing physicians in war plant communities are often greatly overworked and will not resent the treatment of minor nonoccupational illnesses and injuries by plant physicians.

Where dormitories and housing projects are built, complete medical care may have to be furnished by plant physicians not only to the workers but to their families, especially if other practicing physicians are not readily available. Steps are being taken to induce physicians to locate in war production areas, particularly in small towns, near housing projects and other places where the number of physicians is now insufficient to meet with the increased burden occasioned by wartime conditions. The exact method for providing these services has not yet been developed.

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CHAPTER 5

NURSING SERVICES

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INTRODUCTION

INDUSTRIAL nurses constitute the largest group of professional workers rendering health and medical services on a full-time basis in industry. Thus industrial nursing ranks as one of the most important components of the industrial health program.

Professional nurses were first employed by commercial establishments almost fifty years ago. The function of these nurses was to visit sick workers in their homes. While home care was advantageous to employer and employee alike, it was soon found that other equally important services could be rendered by nurses through giving care and health supervision to the workers at their places of employment.

Almost a quarter of a century ago the position of the industrial nurse was defined as follows:¹

If it was of importance to nurse the employee when ill, it was of still greater importance to prevent him from becoming ill—to see that slight injuries were attended to at once; that the sanitary condition of the plant where he worked was good; that the worker was protected from all undue hazard; and that the first symptoms of disease should be noticed to prevent future disability. She should know something of factory laws, and a great deal about sanitation, and should make a special study of the hazards of industry.

This point of view suggests the wide variety of duties expected of the nurse employed in industry.

Today, approximately 10,000 graduate, registered nurses are employed in industrial, commercial, and service establishments throughout the United States. They are found in all types of industries and in all sizes of plants. A nursing program may be in operation not only where the hazards are great, but also where working conditions are ideal. The extent to which the management concerns itself with the health and welfare of its executives and employees determines the provision for nursing service. The

industrial nursing program in a large banking and investment corporation is often as extensive as that found in a machine shop where the occupational hazard is far greater.

The standardization which characterizes other specialized nursing services is largely lacking in industrial nursing. The duties and responsibilities of the industrial nurse vary greatly because of the differing occupational needs and health requirements of workers. In general, however, a pattern has evolved which can be used as a practical guide in the establishment or improvement of an industrial nursing service.

SCOPE OF INDUSTRIAL NURSING

The scope of industrial nursing today has been considerably extended by the acceleration of employment of workers in war production industries on the one hand, and the current shortage of physicians available for industrial medical service on the other. Industrial nurses are now called upon to relieve physicians of many technical, administrative, and routine procedures. *Industrial nursing combines the activities of hospital nursing and public health nursing.* Frequently the nurse is also called upon to perform the duties of an X-ray or laboratory technician or of a physiotherapist.

The care of injured or ill workers is of paramount importance and therefore the professional skills characteristic of hospital nursing are essential. The modern industrial medical department recognizing the importance of health conservation and promotion provides for health supervision. Such health supervision of workers requires the application of public health nursing principles and techniques. Moreover, health promotion activities are becoming more important owing to the current increase in the employment of older and less physically fit workers.

The number and variety of duties expected of the nurse are determined by the extent to which medical and safety services have been or are being organized within a given industry. In general, however, the activities performed by nurses in industry may be classified as follows:

1. Assistance with the management and maintenance of the plant medical department.
2. Nursing care of occupational injuries and illnesses; emergency care of nonoccupational illnesses.
3. Participation in the medical examination program.
4. Participation in the health education program.

5. Assistance with the accident control and safety education program.
6. Assistance with environmental sanitation.
7. Participation in the plant welfare program.
8. Nursing service to ill or injured workers in their homes.

ACTIVITIES OF INDUSTRIAL NURSE*

It is recognized that while industrial nurses engage in many or all of the activities indicated in the general classification, the emphasis placed upon any one of the 8 groups depends on several factors. Not only the attitude of the management toward the health and welfare of employees, but also the nurse's own professional preparation, vision, and initiative, condition the program in which she participates. Furthermore, the health and welfare facilities available in the community lessen or enhance the services needed within the plant. It is understood that all services rendered by the nurse are carried out according to instructions or procedures outlined by the physician in charge.

Maintenance of Plant Medical Department

Medical service in industry is rendered on a full-time, part-time, or "on call" basis. Obviously, the availability of the physician affects the kinds of service and the degree of responsibility expected of the nurses.

In plants where there is at least one full-time physician, the nurse's responsibility for management and maintenance of the plant medical department is entirely dependent upon the responsibility delegated to her by the physician. Normally, her duties include (1) the ordering and arrangement of necessary supplies and equipment, (2) scheduling workers for examinations and retreatments, and (3) completing and filing records.

In plants where the medical service is part-time, the nurse's responsibility increases in proportion to the amount of time the physician gives to in-plant services. Under these circumstances the nurse organizes and maintains the plant dispensary under

* During 1942 a nationwide survey of the duties of nurses in industry was in progress under the auspices of a special committee of the Public Health Nursing Section of the American Public Health Association. The data collected have been used as a basis for the preparation of this section on the activities of the industrial nurse. Recommendations for acceptable practices of industrial nursing prepared by the Advisory Group of the Committee to Study the Duties of Nurses in Industry are given at the end of this chapter.

the guidance of the physician. In instances where the doctor serves only "on call" for the most part the nurse is given full responsibility for setting up and maintaining the dispensary. Regardless of whether the medical service is rendered on a part-time or "on call" basis, the industrial nurse represents the medical department in the absence of the physician in any interdepartmental planning and discussions. Likewise, she is responsible for integrating the medical services with other plant services.

Nursing Care in Occupational Injuries and Illnesses; Emergency Care in Nonoccupational Illnesses

The nurse's responsibility for care where there is a full-time physician is limited to assisting the physician or to the care of workers who do not need the attention of the physician. It is advisable that definite procedures be set up *in writing* to indicate the extent of nursing care.

In plants where a full-time physician is not employed, the nurse sees all workers who are injured or ill and exercises judgment relative to medical treatment. Under these circumstances the nurse may administer treatment, give emergency treatment until the part-time physician makes his regular visit to the plant, or she may immediately refer the worker to the physician at his office. In any instance, the nurse should have the guidance of *written standing orders* outlining the procedure to be followed.

First Aid Stations.—To facilitate treatment in industrial accident cases in very large organizations, an increasing number of industries are establishing first aid stations throughout the plant. These are conveniently located in areas where the accident hazard is greatest. The highest degree of efficiency can be achieved in these stations when well qualified graduate nurses are assigned to render the emergency care. The purposes of providing such stations are (1) to give immediate emergency treatment, (2) to reduce the volume of treatments and retreatments necessary in the central dispensary, and (3) to reduce the time consumed by the worker in going for care. Professional skill and judgment are required of the nurse if these purposes are to be achieved.

Further, these first aid stations can be utilized in giving health supervision to workers coming for care, since the volume of emergency work rarely requires the nurse's full attention. Also, the nurse assigned to the station has a better opportunity to become acquainted with the occupational environment of the

employees and the manufacturing processes of the unit in which she works. She can therefore be of more value to the health program because she understands the conditions arising out of the employment.

Participation in the Medical Examination Program

In most establishments the nurse's participation in the medical examination program consists of (1) noting on the examination record preliminary data relative to the personal and occupational history of the worker, (2) explaining to the worker the value of the examination and the procedure used, (3) making vision and hearing acuity tests, (4) taking specimens for serological and other laboratory tests, (5) making blood pressure readings, and (6) chaperoning women workers at time of examination.

In the smaller organization the nurse promotes the medical examination program by encouraging workers to secure a medical examination from their family physicians and by taking health histories.

Participation in the Health Education Program

In plants having full-time medical service, the responsibility of the nurse for health education has been limited to informal counselling with workers who are being treated for injury or minor illnesses. Pressure of work frequently prevents full utilization of these opportunities, but the results obtained when *planned health instruction* is given well justify the effort. On these occasions the worker is psychologically ready for instruction, and his time away from work is lessened by taking advantage of his coming in for emergency care.

Opportunities for the nurse to supplement the health instruction given by the physician at the time of preplacement and periodic medical examinations should be utilized to the fullest extent. For example, the meaning and value of certain serological and laboratory tests can be pointed out at the time blood and urine specimens are taken. Increases in the number of workers to be examined and the current shortage of physicians available for industrial medical service necessitate an extension of the nurse's responsibility in this regard.

In plants where an active program for the control of non-occupational illnesses is in effect, more responsibility is given the nurse in the follow up of remediable physical defects and

incipient chronic illnesses. Instruction given by the nurse and symptoms described by the worker should both be *carefully recorded* as a part of the medical history.

In some establishments a more formal health education program is the responsibility of the nurse. She may teach regularly scheduled classes in home nursing, standard or advanced first aid, personal hygiene or nutrition. Frequently not only workers but also families of workers enroll in these classes and benefit thereby.

Other health education activities of the nurse often include the maintenance of health materials on the bulletin boards, distribution of health literature, and contribution of articles on health to the plant publication.

Assistance with the Accident Control and Safety Education Program

In plants in which full-time personnel is employed for planning the accident control and safety education program, the industrial nurse contributes by tactfully interviewing the injured worker and recording pertinent information relative to the accident at the time she is rendering nursing care. Carefully worded instruction given during the treatment of minor injuries is frequently an effective accident prevention and safety education measure. The attitude of the nurse and her disciplined behavior can frequently prevent emotional disturbances of injured workers and other employees who have witnessed the accident.

In smaller organizations where specialized safety personnel is limited, the industrial nurse can make an additional contribution to the accident control and safety education program. Here her activities include planning with the management and foremen for safety programs; investigation of accidents; making recommendations for control measures; organization of safety committees; participation in safety committee activities; care, maintenance, and issuance of personal protective devices; maintenance of bulletin boards; and arrangement for safety education meetings.

Assistance with Environmental Sanitation

In industries where sanitary engineers are employed, the responsibility of the nurse for sanitary inspections may be limited to assistance with the inspection of toilet, wash, rest, and change room facilities for the women workers. Routine inspection

of the lunchroom or cafeteria may also be delegated to the nursing personnel. As the number of women workers increases it will be necessary to employ matrons who are responsible for the cleanliness of women's facilities and also to limit the amount of time workers spend in the rest rooms. The selection, training, and supervision of such matrons may well be the responsibility of the nurse or nursing supervisor.

In plants where sanitary engineers and responsible cleaning crews are not employed, responsibility for sanitary inspection for the health protection of the workers may be delegated entirely to the nurse.

Participation in the Plant Welfare Program

In many plants a department is provided to handle all of the worker welfare activities—recreation, group sick benefits, group hospital insurance, financial aid, and family social problems. In such plants the nursing personnel assists to the extent of referring problems to that department since frequently the workers explain their difficulties to the nurse at the time treatments are being given. In plants where a welfare department is not in operation, the nurses may be responsible for all of the welfare activities.

In many instances the lunchroom facilities may be operated by the welfare department. As explained in the chapter on *Organization of a Plant Medical Department*, a dietitian or nutritionist should be responsible for the nutrition program. However, if such a worker is not employed, the nursing personnel may serve advantageously.

Nursing Service to Ill or Injured Workers in Their Homes

Frequently in the smaller industries the plant nurses visit absent workers in their homes in addition to serving in the dispensary. In larger industries additional nurses for home visiting are employed. Sometimes an industry will arrange with the local nursing association to make home visits. No matter what the arrangement, this service is valuable not only to the worker but also to the company. However, adequate time must be scheduled for visits, and transportation must be provided for the nurse if any good is to be realized by the worker from the nursing care he receives or any benefit by the company in the control of absenteeism.

Among the reasons for making home visits are: (1) to give nursing care to ill or injured workers; (2) to assist the worker with social problems; (3) to give health supervision; (4) to determine eligibility for benefits; and (5) to determine cause of absence. The policy of rendering care to the worker's family varies. Where villages are maintained for workers, home visiting by the plant nurses with care and supervision for the entire family is common practice.

Community Nurse for Home Visits.—Several factors make it more desirable for an industry to enter into a contract with a local visiting nurse association rather than to employ a nurse for home service. Workers often object to having an employee of the company visit in their homes. The travel time necessary for a nurse to make a special trip to the home of a worker who is commuting from a great distance makes the cost of such visits in time and money unpractical. Fluctuating employment frequently prevents a satisfactory home visiting program through the use of plant nurses. The number of industries purchasing group insurance policies which provide nursing care is growing rapidly, thus decreasing the need for plant home visiting service. Finally, and of great importance, is the recognition on the part of industrialists of the need to avoid duplication of service—duplication of activities performed by a community agency in which they, as responsible citizens of the community, are interested. When this last factor is fully appreciated, industry will recognize the advantage of having the community nurse serve the plant for all home visiting, inasmuch as she may already be serving the family and therefore is in a position to contribute her knowledge of family health problems to the industrial medical department.

In the majority of industrial centers there is a nonofficial visiting nursing association or an official public health nursing group with which the plant may make satisfactory arrangements for home visiting of workers.

PREPARATION FOR INDUSTRIAL NURSING

The activities of the industrial nurse described above indicate the varied duties and responsibilities which are expected of her. In order that she may be able to meet these responsibilities successfully she needs to have certain preparation and personal qualifications. Although opportunities for special training in industrial nursing are still limited, qualifications which are pos-

sible of attainment are described in the recommendations appearing at the end of this chapter.

SUPERVISION OF NURSES IN INDUSTRY

Where several nurses are employed in an industry one nurse should be designated as supervisor. The advantages of having a supervising nurse are many. She serves to establish more uniform nursing practices, to insure higher quality of work, to give professional guidance and leadership to the nursing staff, and to relieve the medical director of the details of handling the nursing service. In plants where nurses are employed for the second and third shifts arrangements for adequate nursing supervision for these two shifts should be made.

The duties of the supervising nurse are:

1. To analyze the nursing needs of the plant.
2. To review the professional history of applicants in order to select nurses with the best qualifications for various positions.
3. To give introductory training to the nursing personnel.
4. To assign nurses to posts of duty; to arrange schedules for hours of work and days on duty.
5. To prepare a manual of nursing procedures regarding treatment, records and reports, clerical routines, ordering supplies, care and use of equipment, health instruction of workers, and cooperative activities to be carried on with other departments in the industry and with health and welfare agencies in the community.
6. To plan and execute a staff education program designed to increase the knowledge of the nursing staff in industrial hygiene, nursing care and treatments, industrial medical science, and the manufacturing processes of the industry.
7. To evaluate the work of the various nurses in order to assist them with any problems of nursing technique, record keeping, or other activities in which they are engaged.
8. To encourage the nurses to become interested in professional organizations and to seek further professional education.
9. To assist the medical director in planning with other departments (safety, welfare, sanitation, personnel, or employment) for more effective health service.

10. To assist the medical director in tabulating and analyzing medical records and making necessary reports.
11. To assist the medical director in planning cooperative activities with community health and welfare agencies.

In plants where more than one nurse is employed but the number does not justify the employment of a nursing supervisor, one nurse should be designated as senior nurse. Her duties will be similar to the supervising nurse except more limited in extent. In plants where only one nurse is employed much assistance, guidance, and leadership may be secured from the nursing consultant of the State or local department of health as described in the following Section.

The ratio of staff nurses to supervisors is usually one supervisor for six to twelve nurses. An assistant supervisor is usually added when there are from twelve to twenty-four staff nurses, and a director of nursing with two supervisors should be employed for twenty-four to thirty-six nurses. When the nursing staff increases beyond thirty-six, additional supervisors for certain services such as examination unit, treatment rooms, first aid stations, operating room, and home visiting will be found advantageous.

A well prepared and experienced public health nurse should be employed as one of the supervisory staff. She will instruct the staff in the principles of health education or supervision and will plan for the utilization of community nursing services for home visiting of absentees.

ASSISTANCE AVAILABLE TO INDUSTRY FROM THE FEDERAL AND STATE INDUSTRIAL HYGIENE PROGRAMS

Federal

For the past several years the activities of the Division of Industrial Hygiene of the National Institute of Health have been increasing. In March 1941, a Public Health Nursing Consultant was assigned to the staff of the Division. The function of this consultant is to augment the services of the public health nursing consultants of the U. S. Public Health Service in the eight districts, to participate in the activities being carried on by the Division of Industrial Hygiene, and to cooperate with other national official and nonofficial agencies concerned with industrial nursing.

State

Many State health department divisions of industrial hygiene provide nursing consultation services to promote nursing services in industry and to further a better utilization of existing industrial nursing services. The activities carried on by the State nursing consultants are:

1. Assisting the medical and engineering personnel of the division of industrial hygiene in planning a State-wide program of industrial health.
2. Rendering consultant services to the individual industrial nurse.
3. Rendering consultant services to industry by the following methods:
 - (a) Obtaining qualified industrial nurses.
 - (b) Assisting with the improvement of the nursing program.
 - (c) Assisting in planning health programs in small industries of 500 employees or less, which do not have a nursing service.
4. Planning for the coordination of all nursing services and other resources in the community for the benefit of the industrial worker and his family.
 - (a) Assisting the plant medical department to make arrangements with local health agencies for home nursing care of sick absentees.
 - (b) Interpreting to the local health and welfare agencies the needs of the industry.
 - (c) Assisting with in-service education programs for the staffs of both the industrial medical department and the public health nursing organizations to enable each to function more effectively in the care of the worker and his family.
5. Stimulating the organization of industrial nurses in the State.
6. Promoting an interest in and an understanding of industrial nursing.
 - (a) Providing speakers for professional nursing meetings.
 - (b) Encouraging the development of courses in industrial nursing in curricula of the schools of nursing and in the universities offering instruction in public health nursing.

- (c) Planning for special educational opportunities for industrial nurses in the form of institutes.
7. Encouraging activities of industrial nurses in State nurses' organizations.
 8. Supplying lists of reference material in industrial nursing for in-service study.

RECOMMENDATIONS FOR ACCEPTABLE PRACTICES

Upon completion of the survey conducted by the Committee to Study the Duties of Nurses in Industry, the Advisory Group* met on January 30-31, 1943, reviewed the analyses of the collected data, and made the following recommendations:

1. Written Standing Orders

It is a recognized principle that all nursing care should be given under the direction of a licensed physician. Standing orders are a protection to the nurse, to the worker and to the management. It is the responsibility of the industrial nurse to procure these written standing orders.

It is recommended that nurses working without the direction of a full-time physician have written standing orders. Where no one physician is responsible for the plant medical service the nurses may secure standing orders from the committee on indus-

* The Advisory Group of the Committee was composed of the following industrial nurses: Polly Acton, *The New York Times*, New York, New York; Loretta Cloney, Southwestern Bell Telephone Company, Houston, Texas; Mrs. Isabel Comstock, Boeing Aircraft Company, Seattle, Washington; Catherine R. Dempsey, Simplex Wire and Cable Company, Cambridge, Massachusetts; Yvonne du Bois, Maryland Casualty Company, Baltimore, Maryland; Mrs. Helen Lindsay Elrod, Caterpillar Tractor Company, San Leandro, California; Winifred Hardiman, The Terry Steam Turbine Company, Hartford, Connecticut; Mrs. Nan Cox Hare, Tennessee Valley Authority, Chattanooga, Tennessee; Marion S. Hitchcock, Westinghouse Electric and Manufacturing Company, Springfield, Massachusetts; Pauline Kuehler, Standard Oil Company, Whiting, Indiana; Mrs. Amy Lamar, Donnelly Garment Company, Kansas City, Missouri; Mary M. Lenhoff, Allied Kid Company, Wilmington, Delaware; Mrs. Margaret W. Lucal, Ohio Rubber Company, Willoughby, Ohio; Elsa H. Lundstrom, Liberty Mutual Insurance Company, Boston, Massachusetts; Agnes Rabitt, Anheuser-Busch, Inc., St. Louis, Missouri; Mrs. Mary Lou Scott, Concan Ordnance, Inc., Terre Haute, Indiana; Mrs. Christian F. Seabrook, Metropolitan Life Insurance Company, Chicago, Illinois; Elizabeth Sennewald, Dolphin Jute Mills, Paterson, New Jersey; Lillian M. Tilley, White Oak Mills, Greensboro, North Carolina; Iva G. Wait, A C Spark Plug Division, General Motors Corporation, Flint, Michigan; Heiltje Wolzak, Owens-Illinois Pacific Coast Company, Los Angeles, California.

trial health of the county medical society.* *It is further recommended* that the nurse working under the direction of a full-time physician have written procedures for her guidance. In plants where non-professional workers are employed *it is also recommended* that written standing orders and/or written procedures for the guidance of such personnel be furnished.

2. Assistance with Medical Examinations

The nurse's assistance during the medical examination may aid the physician to secure the worker's understanding of the value and use of the medical service, and the value of the examination and the procedure to be followed. Such assistance will also conserve the time of the physician.

It is recommended that nursing assistance in the medical examination, pre-placement and other, should include the following activities: (1) interviewing the worker previous to the examination, and taking both the personal and occupational history; (2) doing routine tests and explaining their significance; (3) taking specimens for serological and other laboratory examinations and explaining their significance; (4) interpreting to the worker plant policies regarding health and welfare, and his responsibility for cooperation; (5) making periodic inspections for symptoms and indications of occupational diseases; (6) making inspections and interviewing worker in connection with return to work permits.

3. Participation in Health Education Program

Conservation of the health of industrial workers in order to improve efficiency and lessen absenteeism is recognized as vital to production. *It is recommended* that the nurse's participation in the plant health education program be extended and improved. Such a program should include definite plans for (1) follow-up for correction of remediable conditions; (2) supervision and rehabilitation of workers with adverse health conditions; (3) maintenance of complete records showing care given for non-occupational conditions; (4) health teaching in the training program; (5) utilization of community resources including private physicians, health and welfare agencies..

* Suggested written standing orders have been prepared by the Council on Industrial Health of the American Medical Association and made available to the component societies for the use of their State and local committees.

4. Assistance with Safety Education and Accident Prevention

The objective of safety education and accident prevention is to reduce to a minimum the rate and severity of accidents. *It is recommended* that the nurse should not be responsible for the planning or direction of the safety program. *It is further recommended* that the nurse assist through the following activities: (1) proper placement of workers according to physical and mental fitness; (2) training course; (3) safety committee work; (4) record and report keeping; (5) individual instruction of workers regarding accident prevention; (6) visual education, movies, posters and printed material; (7) distribution and care of protective equipment.

5. Assistance with Plant Sanitation

Plant sanitation affects both the health and the morale of the worker and so is of direct interest to the medical department.

The industrial nurse should know the requirements of factory laws as they relate to illumination; ventilation; cleanliness; provision of adequate toilets; rest, wash and change rooms; and eating facilities.

Usually these facilities are not under the direct supervision of the nurse but she may supervise the training of matrons for this duty, and may be required to make routine inspections. The nurse's sickness and accident reports may be utilized to show the need for better illumination or ventilation of work areas and it then becomes the nurse's duty to recommend investigation by the engineering, maintenance or other responsible departments.

It is recommended that the nurse show an active interest in all phases of plant environment that affect the health and morale of the worker. However, direct responsibility for the supervision of plant sanitation should be delegated to other departments whenever possible.

6. Participation in Welfare Activities

Welfare activities in a plant are recognized as contributing to the morale and efficiency of the worker. *It is recommended* that nurses participate in and promote welfare activities. The nurse's participation may include: (1) development of group sick benefits, hospitalization and life insurance plans; (2) personal counseling with workers regarding welfare problems; (3) development of recreation programs; (4) cooperation with local welfare

agencies; (5) planning of cafeteria, lunch rooms and canteen services.

7. Records and Reports

Records and reports are to the industrial nurse what book-keeping is to the accountant. They make it possible for her to prove to management the desirability of and the value derived from having a medical department.

It is recommended: (1) that the medical records be kept strictly confidential except as interpretations thereof are needed by management; (2) that all medical records be kept in the medical department and available for use each time a worker presents himself for care; (3) when the physical examinations of workers are made outside the plant, the records or copies thereof be made available to the nurse; (4) clerical assistance should be provided in order that the nurse's time may be conserved and records will be adequate. *It is further recommended* that the following types of records and reports are needed: (1) daily record or log; (2) individual record including the medical examination, clinical visits, and the correction of remediable conditions; (3) disability absentee records; (4) compensation records and reports; (5) monthly and annual reports to management.

8. Professional Supervision of Nurses in Industry

Supervision is a democratic situation in which a person, who has had opportunity to acquire a broad knowledge of her field and has proved ability in her field, offers to share her knowledge and experience with another person in such a way as to help that person to do better work more easily and with greater satisfaction.

It is recommended that where two or more nurses are employed, one nurse be designated as one of the following, depending upon the size of the nursing staff and the amount of responsibility delegated to her: director of nursing service, nursing supervisor, chief nurse, head nurse, or charge nurse. *It is further recommended* that when the nursing staff of the particular industry is not sufficiently large to warrant the employment of a nursing supervisor, the facilities for advisory service offered by the State department of health or the insurance company should be utilized.

9. Special Technical Services

Since it is frequently necessary for the industrial nurse to do laboratory work, take X-rays, give physiotherapy treatments, make electro-cardiograms and basal metabolic tests, *it is recommended* that the nurse have special training in the techniques of rendering each of these services when they are required of her. *It is further recommended* that when the volume of special technical services requires the time of one individual, a technician rather than a nurse be employed for these services.

10. Nonprofessional Clinic Assistants

In keeping with the National effort to conserve nurse-power during the war emergency, *it is recommended* that nonprofessional clinic assistants be employed in so far as possible and that the following duties be assigned to them: (1) securing of specimens and care of specimen bottles; (2) filling of hot water bottles and ice bags; (3) bed making; (4) sterilization of instruments and supplies; (5) assistance with dressings; (6) making surgical supplies; (7) care of change rooms, rest rooms and toilets; (8) training of matrons. *It is further recommended* that there be written instructions governing the activities of the nonprofessional clinic assistants and that such assistants be supervised by the nurse.

11. Home Nursing Service

Home nursing care for injured and ill workers aids in the promotion of the general health of workers, reduces absenteeism and contributes to the morale of workers. *It is recommended* that home nursing service be provided by the plant. The plan for visiting sick or injured workers in their homes should be developed to secure maximum benefits to the workers and the plant. Employment of nurses for this service may be necessary where community resources are not available or cannot be coordinated with company policy.

12. Duties outside the Medical Department

In many instances when a nursing service is being initiated by industry the nurse combines with her nursing functions various duties unrelated to health services. Since it has been demonstrated that a plant employing as few as a hundred workers can profitably employ a nurse full time, *it is recommended* that the nurse's activities be limited to those of the medical department.

13. American Red Cross Home Nursing and First Aid Classes

Home nursing classes afford the worker an opportunity to improve her knowledge of general health and to gain an understanding of methods of caring for sick members of her family. First aid instruction makes the worker more safety conscious. *It is recommended* that nurses in industry take the necessary steps to become authorized Red Cross Home Nursing and First Aid instructors.

14. Plant Protection Plans

In the present war emergency it is desirable that industrial nurses, particularly those situated in the coastal areas, should participate in the planning and the activities of the plant protection program. Her duties may include organizing and/or teaching first aid classes; selecting locations and essential first aid equipment for first aid stations; conducting drills; supervising emergency canteens; and arranging with local civilian defense authorities for transportation and hospitalization of casualties.

Numerous inquiries have been made regarding personnel policies and organization plans. Therefore, the following outline with recommendations is included:

15. Qualifications

1. *Personal*

- (a) An interest in, and an ability to work effectively with, all types of people.
- (b) Good physical health.
- (c) Emotional stability.
- (d) Initiative and good judgment.
- (e) Resourcefulness.
- (f) Ability to organize, especially where nursing supervision is not provided.
- (g) Ability to appreciate the importance of one worker's health to the efficient operation of the industry as a whole.

2. *Academic*

- (a) High school graduation.
- (b) Advanced education on a college level, desirable.
- (c) Ability to type for the purpose of record keeping, desirable.

3. Professional

- (a) Graduation from an accredited school of nursing connected with a hospital, which had a daily average of 100 patients or affiliations with other schools of nursing to provide a broad clinical experience in medical, surgical, obstetrical, and pediatric nursing.
 - (b) Registration in the State of employment, in accordance with the Nurse Practice Act.
 - (c) Post graduate study in industrial nursing with public health aspects, desirable.
4. *Experience* in hospital emergency room, out-patient surgical department, industrial clinic, and public health nursing, desirable.

It is recommended that industrial nursing organizations make an effort to encourage the employment of nurses who have had the industrial nursing preparation available at the present time.

16. Membership in Professional Organizations

Nurses should maintain their professional affiliations, and be interested in keeping up with advances in their profession. The affiliations desirable are alumnae, district, State and American Nurses Associations, the local industrial nurses group and the American Association of Industrial Nurses, State organizations for public health nursing, and the National Organization for Public Health Nursing.

17. Salary

The basis for salary (or compensation) should be the same as that of supervisors of departments, according to the responsibilities involved and the qualifications including experience which are required. *It is recommended* that a job analysis be made to depict the responsibilities involved in the particular position and that the salary be commensurate with the responsibilities involved.

18. Relation of Medical Department to Other Departments

To facilitate the effective operation of the medical department, the person in charge of the medical department should be able to discuss problems with top management. Management should consider its medical department as an asset rather than a liability or a luxury and it should be given the status which it merits—on a par with operations.

It is recommended that the medical department, regardless of size, should be responsible to an executive of the organization.

19. Number of Nurses per Unit of Employees

The number of nurses employed should depend on the type of industry and the number of workers. For the maintenance of complete health services in an industry *it is recommended* that there be 1 nurse for up to 300 employees, 2 or more nurses for up to 600 employees and 3 or more nurses up to 1,000 employees, 1 nurse per each additional thousand employees up to 5,000, and 1 nurse per additional 2,000 employees. Additional nurses may be required because of hazards and to supply service for second and third shifts. This number will be reduced by the number of technical and non-professional workers employed in the medical department. Smaller industries which do not have serious occupational hazards (those employing less than 500 workers) may find part-time nursing services adequate.

During the war emergency it is essential that careful consideration be given to the utilization of non-professional clinic assistants under supervision of a nurse to keep at a minimum the number of nurses needed, and that the activities of the nurse be limited to essential nursing functions.

20. Distribution of Nursing Service

The National Nursing Council for War Service recommends* that industrial nurses who are not essential for maintaining minimum health services should serve with the armed forces.

It is considered that the industrial nurses who are essential for maintaining minimum health services are:

1. The nurses who have established health programs in essential industries.
2. The nurses who are holding administrative or supervisory positions in the medical department of an essential industry.
3. The nurses who have special skills or preparation essential to the maintenance of the medical department.

It is recommended that staff nurses who are eligible for military service and who may be replaced by a nurse not eligible for such duty should be encouraged to enroll for service with the armed forces and should be granted military leave.

* Priorities for Nurses. National Nursing Council for War Service, 1790 Broadway, New York, N. Y.

21. Part-Time Nursing Services for Small Industries

While comparatively few employers have felt that full-time nursing service for less than 500 employees is a sound investment, it is being realized to an increasing extent that the number of employees cannot be used as a criterion concerning the need of an industrial health program, rather the hazards associated with the working environment and the health problems of the workers are the deciding factors. Effective part-time nursing services have been developed in some cities to meet the needs of the smaller industries through utilization of community nursing agencies and through several plants sharing the services of one nurse. Frequently such part-time service has demonstrated the extent of service needed. In some instances the part-time service has consequently developed into a full-time service and in other instances the part-time service has been adequate to meet the needs of the plant.

It is recommended that the use of part-time nursing services should be extended, particularly in plants employing less than 100 workers. *It is further recommended* that local industrial nursing organizations cooperate with the State industrial hygiene divisions in giving guidance to individuals or agencies which may be utilized in providing such services.

22. Source of Supply

In the past, many employers have not been aware of the professional channels through which nurses might be secured for positions in industry. Various sources have been used with the result that frequently selection of the nurse has been made without the duties and responsibilities of the position being given proper consideration.

It is recommended that nurses for industry be obtained through professional nursing channels such as: (1) registries approved by local or State nurse associations; (2) Nurse Placement Service*; (3) schools of nursing and universities offering courses in industrial hygiene; (4) insurance companies; (5) divisions of industrial hygiene in State departments of health. *It is further recommended* that the local industrial nurses group act in an advisory capacity to the above organizations in regard to the needs of industry and available nurses.

* 8 South Michigan Avenue, Chicago, Illinois.

SUMMARY

The material presented in this chapter may be conveniently summarized under five heads: (1) scope of industrial nursing, (2) activities of the industrial nurse, (3) preparation for industrial nursing, (4) supervision of nurses in industry, and (5) assistance available to industry from the Federal and State industrial hygiene programs.

The chapter concludes with the recommendations promulgated on January 30-31, 1943, by the Advisory Group of the Committee to Study the Duties of Nurses in Industry.

The scope of industrial nursing has been extended as improvements have been made in industrial medical practice. The activities in which the industrial nurse engages vary greatly according to the type of industry and the provisions for medical and safety services within the plant. Moreover, the preparation, understanding, and vision of the nurse contribute to the type of program in which she participates. Nursing care of the injured and ill workers remains the first responsibility of the industrial nurse. However, the necessity for health conservation of workers through medical supervision and health education makes health teaching of considerable importance.

As industrial nursing has become recognized as a special field of nursing, and as the duties and responsibilities of the nurse become more uniform, the desirability of having courses for post-graduate preparation for the special field has grown. However, graduation from an accredited school of nursing and certain personal qualifications remain the usual requirements for nurses employed in industry. In the discussion of the preparation and qualifications, an effort was made to present current practice of medical directors and other plant officials when employing nurses and in addition the consensus of opinion of industrial physicians and industrial nurses concerning desirable qualifications.

That the service rendered by the graduate registered nurses in industry is necessary for the health protection of workers is indicated by the increase in the number of nurses employed. The knowledge and experience gained by industrial nurses during the past many years provide a basis for future development.

ACKNOWLEDGMENTS

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author is indebted for the many helpful suggestions submitted, and the encouragement offered by the nurses represented.

Acknowledgment is made to the following for their review of the material and the constructive criticism offered: Dr. D. L. Lynch, Board of Directors, American Association of Industrial Physicians and Surgeons; Dr. L. D. Bristol, Council on Industrial Health, American Medical Association; the late Mr. E. J. Downing, National Safety Council; and Mr. J. J. Bloomfield, Board of Directors, American Industrial Hygiene Association.

The author is indebted to Assistant Statistician V. M. Trasko, Division of Industrial Hygiene, National Institute of Health, for her analysis of the data from the survey of the Duties of Nurses in Industry.

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CHAPTER 6

DENTAL SERVICES

Lyman D. Heacock, D.D.S., M.P.H.

THE need for the rapid production of war material has focussed the attention of industry on all factors that slow up production. Ill health is one of the major causes of inefficiency and loss of time from work, and defects of dental origin are one of the causes of ill health.¹

In the past the need to eliminate all possible causes of ill health led to the inclusion, by a few industrial concerns, of various types of dental service in the plant medical program. Some of these programs have been operating for many years.^{2, 3, 4}

These programs supply varying amounts of service from examination and recommendation for dental care to complete dental service for the employee and his dependents.^{1, 2}

This great variation in what has been considered adequate industrial dental service has caused some confusion in the minds of war industrial groups who, in their desire to reduce loss of production time, are planning greater protection for the health of their employees by increasing the amount of health service given in their plants.

THE PROBLEM

The syndrome of a decayed tooth, abscess, and focus of infection is thought to be the direct or indirect cause of many of the ills that are responsible for the millions of days lost from work each year because of illness. In addition, poor oral hygiene in combination with continued exposure to physical and chemical agents used in many of the industrial processes frequently results in the gums becoming inflamed and painful. If treatment is delayed diseased and infected gums may cause more serious illness.⁵

Occupational Hazards

The physical, chemical, and bacteriological hazards to which the worker is exposed in his working environment, have engaged the attention of safety and industrial engineers and industrial

physicians for many years. Although many of the known hazards have been greatly reduced, the gearing of industry to an all out war effort and the use of many new raw materials and chemicals, have produced new hazards as well as increased the danger of exposure to the better known ones.

Signs of overexposure to many of these hazards may be discovered early in the tissues of the mouth and oral cavity, and a careful diagnosis of oral conditions by a dentist may be the means of *discovering new hazards* to which the attention of the industrial engineer and physician should be directed.

The industrial dentist must be qualified to recognize and record as well as treat mouth lesions resulting from exposure to industrial hazards of occupation.⁵

Accidents resulting in broken jaws and lost teeth are common in certain types of industry; in most of the States, under existing legislation, they are compensable.

Nonoccupational Disease Effects

Not only are there occupational hazards which affect the teeth, but some of the nonoccupational diseases such as syphilis, and diabetes, at times display signs of attack in the tissues of the mouth and oral cavity. Moreover, it is possible to make an early diagnosis of some of the more serious nutritional deficiencies by their distinctive oral manifestations.^{5, 6}

A *well planned dental program* giving consideration to improving the dental health of the workers will aid in achieving *maximum production* in the plant by: (1) improving the health and efficiency of the personnel; (2) decreasing illness and the consequent loss of time from work; (3) decreasing costs to workers and employers through reduction of wage losses, cost of illness, compensation costs, and insurance premiums; and (4) promoting morale.

PLANNING THE PROGRAM

When planning a dental program for an industrial plant, it is well to remember that the dental service is a part of the whole industrial hygiene program and as such it is essential that it be coordinated with all the health activities within the plant. Dental findings and services are a definite part of the whole health picture of the worker. The industrial physician is well trained in the diagnosis and treatment of deviations from the normal of parts of the human body other than those tissues and structures

of the oral cavity which are included in the field of dentistry. The dentist is therefore as necessary a member of the industrial hygiene staff as are the physician, the nurse, the chemist, and the engineer.

The dentist will plan and administer the purely dental phases of the industrial hygiene program, and will collaborate with the other members of the medical staff in coordinating the dental health of the worker with factors that influence his general health.³

The minimum amount of dental service rendered in an industrial plant which is engaged in war work, is determined by the service necessary to secure for the worker good oral hygiene, and freedom from pain and infection. A greater amount of service may be attempted if circumstances warrant it.

In planning a program, it is necessary to consider certain existing factors, any one or combination of which will influence the working plan. Some of these factors follow.

Need

The type of industry often dictates the need for certain kinds of dental service. The raw materials used, for example, lead, phosphorus, acids, mercury, and radium, and the industrial processing may cause oral conditions which will necessitate the placing of emphasis on specialized diagnostic service and certain dental operations. Thus, when some of the heavy metals are used, prophylaxis and the preventive filling of teeth are essential for the prevention of serious sequelae.⁵

The need for dental care is almost universal. Those plants in areas where there is an insufficient number of practicing dentists, may find it necessary to increase the amount of services rendered their employees. It may also be found necessary to make some provision for the dental care of the dependents of employees, if large worker groups are moved into war industrial areas.

Available Consultative Service

Advice and assistance in planning plant dental programs can be secured by consulting with (1) the State health department through its dental and industrial hygiene divisions, (2) the State and local dental societies through their committees on industrial dentistry, (3) the American Dental Association through its

Council on Dental Health, and (4) the U. S. Public Health Service through its industrial dental consultative service.

State health departments, cooperating with representatives of the State and local dental societies, are developing programs which can be fitted to the particular problems of industrial plants. They will be able to advise on many of the questions which are likely to arise in connection with the "factors which will influence the working plan."

It will be possible through these agencies to secure a list of dentists who are willing to cooperate with industry by caring for the employees who are referred to them for dental treatment. From these lists, also, dentists for full- or part-time industrial dental work may be recruited.

State Dental Practice Acts

Each State has passed legislation which defines how and by whom dentistry may be practiced within the State. A variety of opinions, legal and otherwise, exists as to what constitutes the practice of dentistry in industry. Before a plant dental program is initiated, it will be necessary to determine the limitations placed on industrial dental practice in the State in which the plant is located.

The Number of Employees and the Dental Personnel Needed

Plants are considered "small" or "large" according to the number of workers that they employ. The dividing line has been arbitrarily set at 500 employees.

The employment of a *full-time dentist* in a large plant is advisable. Industrial dental work, while it includes many of the features of the general practice of dentistry, also demands the application of the principles of public health and hygiene, and special knowledge of the oral manifestation of occupational disease. *This application of dentistry is a specialized field of industrial medicine.*

The number of employees that one full-time dentist can properly handle, depends on the amount of service that each individual will receive, the length of time that the program has been operating successfully, and the number of personnel who will assist him.

A group of small plants may find it necessary to employ, collectively, the services of a full- or part-time dentist, either at

offices in the plants, a central clinic for several plants, or in his private office.

The services of a *dental assistant* will increase the efficiency of the dentist and make it possible for him to care for a larger number of employees.

Dental hygienists are permitted to examine and clean teeth under the supervision of a dentist in many of the States. The employment of a dental hygienist will relieve the dentist of much of this type of work, thereby increasing the number of employees that can be cared for by the dental service.^{1, 8}

Availability of Dentists

The commissioning of large numbers of practicing dentists by the armed forces, has not only depleted the number of dentists available for civilian needs, but has also disturbed the distribution of dentists among the population. The rise of war industrial areas has further complicated the distribution problem.

The number of private dentists, practicing in the area in which plant employees live will, in a measure, dictate the amount of dental service that it will be necessary to perform in the plant, since it is futile to advise employees of the necessity for certain types of dental work, if there are no local facilities for meeting the need.

It is hoped that dentists will move into these expanding population areas and so budget their services that the greatest number of people may be supplied with necessary dental service.

Location of the Dental Office

Ideally, the dental office is placed in or near the plant and if possible in close proximity to the medical services. Thus, the worker can receive emergency service with a minimum of time lost from his work, and patients can be easily referred between the medical and dental services. Such an arrangement would facilitate periodic examinations and the resultant check-up would determine whether the necessary work had been completed between examinations.

Service Payment Responsibility

Many methods are being used to pay for all or a portion of the dental services rendered. The problem is to find the payment method which is acceptable to those participating. Generally speaking, the plant which employs a full- or part-time dentist

for examination, prophylaxis and emergency work, pays for the total cost of this dental service.²

Conclusion

A consideration of all the factors discussed above will result in an understanding of the local conditions which operate to limit the dental service program, and definite plans can be made for attaining the dental health objective, namely, the service necessary to secure for the worker good oral hygiene and freedom from pain and infection.

THE PROGRAM*

There are certain *essential* features that should be common to all industrial dental programs. They are enumerated as a foundation upon which programs expressing local needs and limitations may be erected. The essential features are:

1. Personnel.
2. Office space, equipment, and supplies.
3. Records and recording.
4. Examination service.
5. Emergency service.
6. Prophylactic cleansing service.
7. Dental health education.

The first three essentials are considered in the following outline as one dental unit for a plant employing from 500 to 1000 employees. Units may be added as the increase in the number of employees warrants. Plants working on shifts may use the same office facilities and increase the dental service by employing another shift of dental personnel. Essentials 3 to 7 inclusive define the work of the dental staff in operating the dental program in a large plant. Some of the operations enumerated in 5 and 6 will be completed by private dentists at the employee's expense.

Personnel

Dentist, dental assistant, clerical assistance, and a dental hygienist, if available.

Office Space, Equipment, and Supplies

A well lighted office conveniently located in or near the plant and equipped with:

1. Dental chair.
2. Dental unit or equivalent facilities.

* Compare Dunning, reference 7.

3. Instrument and surgical cabinets.
4. Necessary instruments and supplies.
5. Boiling water sterilizer.
6. Auxiliary illumination.
7. X-ray unit and supplies.
8. Dark room with equipment and supplies.

Records and Recording

An adequate record system should be installed with provision for filing records, including X-rays. The importance of proper recording cannot be overstated. Selected data, accumulated on the patient's record card, will not only present a picture of the patient's needs and corrections, but will furnish additional information for statistical investigation. Thus it will be possible to evaluate the program and determine the changes necessary for the betterment of the service. The dental record card or a copy thereof should become a part of the patient's medical record and should be designed to include data on the following:

1. Abnormal conditions of the teeth, jaws and other tissues and structures of the oral cavity. Special attention should be given to the recognition of manifestations of occupational disease.
2. The patient's oral condition for at least 5 years on a basis of one examination each year. This will include charting of decayed, missing, and filled teeth requisite, among other things, for determining improvement in the dental health of the employed group.
3. Time lost from work because of oral sepsis.
4. Information relative to the patient's general physical condition that might have bearing on his dental condition.

Examination Service

The preplacement examination and possibly the periodic examination should be made concurrently with the medical examinations of all employees. The examination should include the following conditions:

1. Every employee should receive a thorough dental examination at least once a year. His initial examination should include a complete mouth X-ray, subsequent X-rays to be taken at the discretion of the operating dentist. Periodic bite-wing X-rays are advised.

2. At the time of the examination the patient should be informed of the condition of his mouth and of those findings that are considered emergency in character. He should be advised to have the emergency work done at once, and informed of the necessity of having all other work completed as soon as possible.
3. Attention should be given to discovering and recording oral evidences of occupational and nonoccupational disease and this information should be transmitted to the medical service at once.
4. Arrangements should be made for the employee to be examined and treated during working hours if possible.

Emergency Service

The following types of service are considered emergencies although other dental operations may be considered so, if it is difficult to obtain service because of an insufficient number of dentists available in the area.

1. Treatment for accidental injuries, toothaches, and acute and chronic infections.
2. Prophylaxis and the filling of carious teeth for employees exposed to certain occupational hazards.
3. Extraction of teeth to eradicate infection.

Prophylactic Cleansing Service

If it is possible each employee should receive one prophylaxis each year. This not only promotes good oral hygiene but presents an opportunity for individual instruction in the regular care of the mouth. This service can be more easily maintained if dental hygienists are available.

Education

Every opportunity should be made to inform the employees of the necessity for early and complete dental care. All known educational procedures can be used effectively in the plant.

SMALL PLANTS

Supplying health services to the *small plant* presents another problem, although the dental health objectives and the *essential features* necessary in a dental program do not differ from those of the large plant.

Small plant employees as well as those in large plants need certain dental services and the problem is the choice of a method that will make these services available. Several methods follow, many of which are now being used by plants; the choice may be one or a combination of these methods:

1. Several plants collectively employing the full-time services of a dentist operating part-time in an office in each of the plants or in a central clinic to which all employees are referred.
2. A plant employing a definite portion of a dentist's time for service, either in the plant office or his private office.
3. A plant supplying office space and equipment for use by a dentist who conducts a private practice made up of the plant's employees.
4. A group of private dentists arranging, with a plant or group of plants, to supply diagnostic service, the employee being referred for service to his own dentist or to this panel of dentists.
5. A number of small plants, scattered over a wide area employing the services of a dentist who operates in a mobile dental office or with portable equipment, thus taking dental service to the workers at the various plants.

No attempt has been made to discuss programs for dental care instituted through the efforts of employee groups, company or employee credit unions, mutual benefit associations, or by local dentists who arrange with these or other agencies, to supply service on some pre-arranged financial basis. Such programs for dental care usually follow one of the methods previously mentioned.

CONCLUSION

Improving the dental health of the workers is a means of improving their general health.

Industry is aware of the fact that disability from sickness and injury is responsible for a tremendous amount of time lost from work each month, thus slowing up the production of materials for war.

Government states its concern in a letter⁹ from the War Production Board to the Production Drive Committees. The letter reads, in part: "Only healthy workers can put into the drive what it takes—vigor, staying power, and the will to win. It is

your job to fight sickness and accidents. See to it that every medical and engineering means of prevention is provided in your plant. Make it a healthful working place. Help the men and women in your plant to keep themselves healthy and on the job."

The *dentists* of the country, individually and through their official organizations—national, State, and local—are keenly interested in aiding in the development of the best type of dental services in industry. Their interest is reflected in their active cooperation with industry and government in endeavoring to *secure for the workers good oral hygiene and freedom from pain and infection.*

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CHAPTER 7

ORGANIZATION OF PLANT EMERGENCY MEDICAL SERVICE AND INTEGRATION WITH THAT OF COMMUNITY

R. F. Sievers, M.D., Ph.D.

INTRODUCTION

INDUSTRIAL plants are important military objectives, therefore protection services should be organized to deal with catastrophes such as bombings and sabotage. Definite plans must be made to cope with these disasters and plant medical departments should participate in the program. Plant medical facilities will seldom be adequate to care for more than a small number of major casualties at a given time. It is desirable, therefore, that community resources be available to a stricken plant when needed.

The following statement was recently issued by the Medical Division of the U. S. Office of Civilian Defense:¹

The primary responsibility for the protection of industrial plants rests upon the operators and owners, and on local and State governments. The War and Navy Departments have included in their protective program the responsibility for surveying and recommending protection within certain civilian manufacturing plants engaged in the production of war material, as well as for plants owned and operated by the War and Navy Departments. The Emergency Medical Service provided in these plants and in all other plants, should be closely integrated with the local Emergency Medical Service. The War and Navy Departments have requested all civilian manufacturing plants having important war contracts to cooperate with the local Emergency Medical Service of the U. S. Office of Civilian Defense. All local Chiefs of Emergency Medical Service should be prepared to cooperate with the management of plants having important War and Navy contracts whenever requested by responsible officials within the plants to do so.

All industrial plants are expected to provide medical services and First Aid equipment within the plant for the care of the injured. In the event of enemy action directed against such industrial plants, the physicians, nurses, and first aid detachments within the plants may be inadequate to care for the serious injuries produced by high explosives or incendiaries. It is the recommendation of the U. S. Office of Civilian Defense that each industrial plant, in addition to providing its own medical staff and first aid equipment, should plan in collaboration with the Chief of Emergency Medical Services of the locality for (1) services of ambulances and Emergency Medical Field

Units when needed, (2) available beds at one or more hospitals to which the severe casualties may be transported, (3) the establishment of a Casualty Station of the Emergency Medical Service within a short distance of the plant, and (4) obtaining the services of Emergency Medical Field Units if needed to supplement the plant medical service during an emergency.

In view of the fact that enemy action against industrial plants may be coincidental with widespread damage to the adjacent community, the mobilization of civilian medical resources during an emergency will be accomplished through the Commander of the Citizens' Defense Corps.

If a plant is miles from a hospital and there is, therefore, a possibility that the injured might be obliged to remain at the Casualty Station for many hours before being transferred to the hospital, the Casualty Station should be larger than the average for a given number of employees and be adequately equipped. It must have cots, blankets, water, heating facilities, and be equipped at least with the emergency medical supplies outlined in Medical Division Bulletin No. 2, equipment lists 1 and 2.

The local Chief of Emergency Medical Service is prepared to advise responsible authorities concerning emergency medical service for industrial, commercial, and service installations, including selection of casualty station sites, and medical supplies which may be needed. He may also arrange for direct telephone lines between important plants and the community control center so that casualties may be evacuated rapidly and emergency medical service provided with the minimum of delay.²

Lieutenant General Somervell has directed³ the Chiefs of Supply Services that, in order "to provide additional emergency medical service in a major emergency, Commanding Officers of all War Department owned plants, controlled or operated by the Supply Services or by the Material Command, Army Air Forces, and all plants which have been assigned to the Chiefs of Supply Services for plant protection inspection, should plan with the local Chief of Emergency Medical Service, OCD, for the use of such emergency facilities as may be available," and "all Plant Protection Inspectors will, on their routine inspections, insure that plans have been formulated for cooperation between the industrial installation and the local Chief of Emergency Medical Service, Office of Civilian Defense."

Thus, although each plant should be prepared to protect itself with the least possible dependence on outside help, arrangements should be made for the exchange of information and assistance between the plant and the community protection services.

MEDICAL SERVICE WITHIN THE PLANT

The plant protection organization should be directed by a group in which are represented the ~~administrative, police, fire,~~

medical, engineering, and safety departments. One of this group, usually the executive or the police or safety representative, should serve as the Plant Defense Coordinator. The Plant Defense Coordinator is chosen for his ability to prepare plans, to organize and train personnel, and to take charge of all activities in the event of an emergency. Figure 1, reproduced from the work cited,⁴ illustrates diagrammatically the activities of the various services.

The plant's medical department should augment its facilities. Casualty Stations, First Aid Posts, Stretcher Teams, and Ambulance Services should be organized and supplied with equipment as recommended by the Medical Division of the Office of Civilian Defense.^{5, 6} If the supplies of the plant and community Emergency Medical Service are standard, confusion will be minimized when it is necessary for the two services to work together. The efficiency of such combined operations will be improved by drills in which both services participate.

A careful record must be kept of all casualties treated at the Casualty Station or First Aid Post. Provision for these records is made on identification tags and in Casualty Record Books which may be obtained from the local Chief of Emergency Medical Service.

Casualty Station

A Casualty Station is a facility located in a building which offers safety and certain essential services, and is easily accessible. Its primary function is to care for injured persons who do not need hospitalization, and thus protect the hospitals of the community from the burden of caring for minor casualties. In addition, it will serve as a center for the dispatch of medical services to the various parts of the plant.

The plant hospital or dispensary is usually well suited to serve as a Casualty Station. In many instances it will be advisable to have additional Casualty Stations within the plant. A Casualty Station of the Emergency Medical Service should be located a short distance from the plant in order that supplemental services may be available. Provision should be made for direct communication between the plant's control room and the Casualty Stations serving the plant.

Plant medical personnel should be organized into teams consisting of a physician, one or more nurses, and assistants. These teams will operate the Casualty Station and, when necessary,

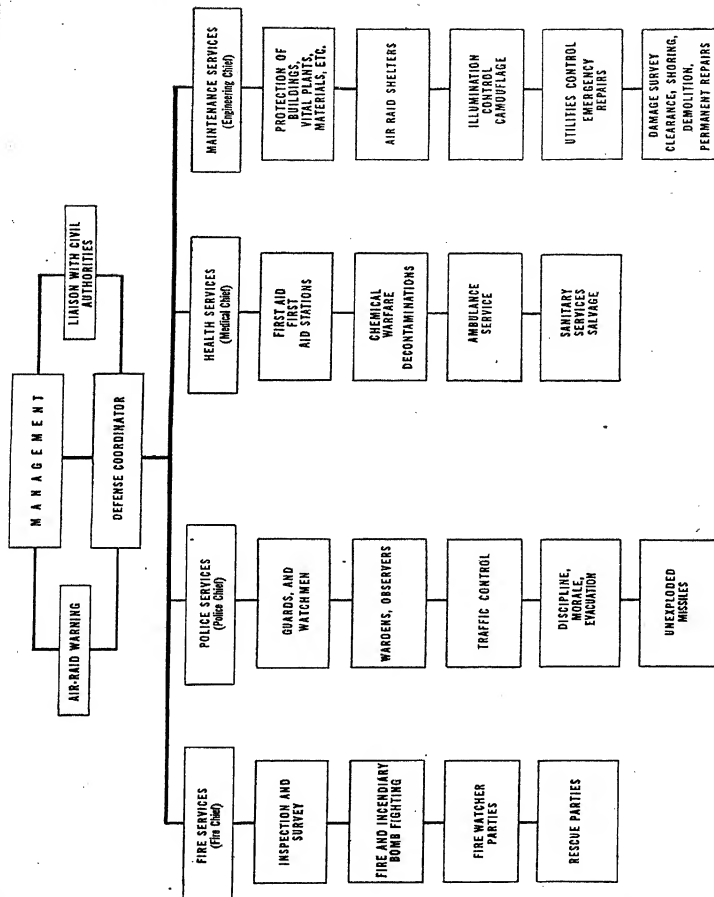


Fig. 1.—Services within the plant.

will advance close to the scene of the incident and establish temporary First Aid Posts.

First Aid Post

The First Aid Post should be established at some point which will provide shelter, safety, and accessibility to ambulances. If a Casualty Station is near the incident, it may serve as a First Aid Post. The personnel of the First Aid Post will (1) ascertain the number, location, and nature of casualties, and determine the priority of treatment and removal, (2) provide emergency first aid treatment, (3) determine the proper disposition for each casualty (hospital Casualty Station), (4) assist in the loading of ambulances, and (5) endeavor to maintain morale in the area.

Stretcher Team

The Stretcher Team which is part of the medical services is composed of four individuals (one of whom is the Leader), who have been trained in first aid procedures, in loading and carrying a stretcher, and in loading and unloading ambulances.⁷ At least five per cent of the plant personnel on each shift should be trained in stretcher bearing.

Many plants have placed boxes containing first aid supplies, such as stretchers, blankets, and bandages at strategic locations. These locations may be used as points of assembly for Stretcher Teams, first aid workers, and other medical auxiliaries.

Stretchers should be provided in the following numbers as a minimum:⁸

For 1-99 employees.....	1 stretcher for each	25 persons
100-499 employees.....	1 stretcher for each	50 persons
	(minimum of 4)	
500 or more employees.....	1 stretcher for each	100 persons
	(minimum of 10)	

Ambulance Service

Many plants now have their own ambulances or have made contractual arrangements for ambulance service. In either case the number of ambulances would probably be inadequate to care for more than a small number of casualties. It is desirable, therefore, that supplemental ambulances such as converted station wagons or small trucks be provided. Conversion of a vehicle for this purpose need not reduce efficiency for its usual function. Some practical methods of conversion are discussed in the "Handbook on Transportation of the Wounded"⁹ which is available through local Defense Councils.

The local Chief of Emergency Medical Service has made a survey of community ambulance facilities and, where they have been found deficient, auxiliary ambulances have been equipped. Should an emergency arise in which the facilities of the plant

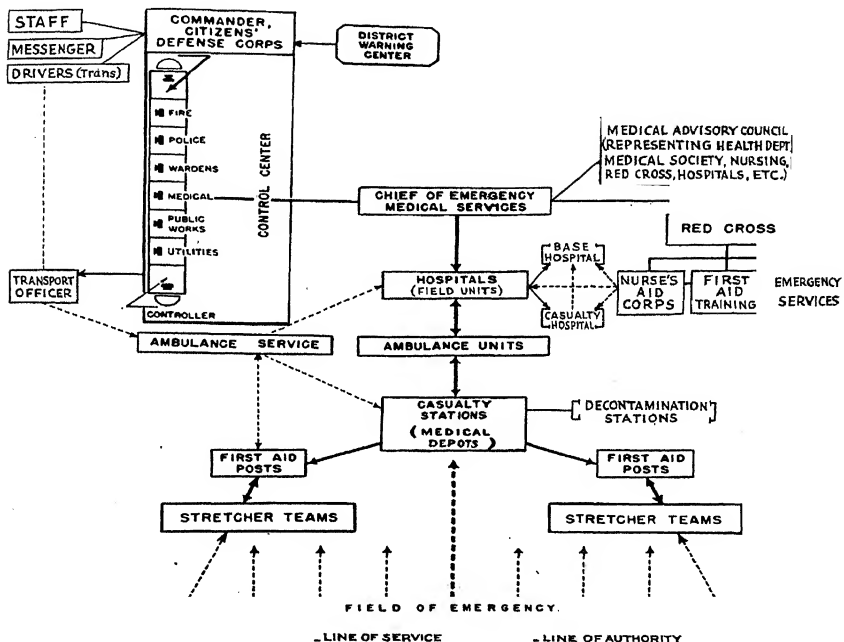


Fig. 2.—Organization of local emergency medical services. On the yellow warning, the chief of E. M. S., or his deputy, reports as medical adjutant to the commander of the control center. On blue or red warning, hospital field units prepare for action, but do not move to casualty stations or first aid posts until ordered by the control center.

proved inadequate, assistance should be obtained by a request to the Control Center.

Gas Defense

It is the responsibility of the plant's medical department to provide for the decontamination of the wounded who have been contaminated with gas and for training the personnel who will

operate decontamination services for the uninjured. This service should be developed with the Plant Defense Coordinator and the Senior Gas Officer of the Citizens' Defense Corps.

Hospitals

Special provisions for the care of air raid casualties should be made in hospitals operated by industrial plants. These include, among others, blackout, protection of glass, increasing bed capacity, and storage of blood or blood plasma. "Protection of Hospitals,"¹⁰ contains recommendations on these and numerous other subjects.

All general hospitals in the community, voluntary as well as governmental, are included in the Emergency Medical Service. The Control Center will designate the hospital to which casualties from the industrial plant will be sent.

Figure 27 illustrates the organization of the Emergency Medical Service.

CONCLUSION

It is important that the medical department of each industrial plant integrate its organization with that of the community or district in which the plant is located. Local Chiefs of Emergency Medical Service are prepared to cooperate with the management of plants whenever they are requested by responsible officials within the plant to do so. A medical officer of the U. S. Office of Civilian Defense has been assigned to assist in this activity.

Prearranged relationships will do much to minimize confusion and provide necessary supplemental services should they be required at the plant in the event of a disaster.

There are a number of publications from the Office of Civilian Defense available from the U. S. Government Printing Office, which may be of assistance in improving the emergency medical program.¹¹⁻¹⁷

ACKNOWLEDGMENT

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CHAPTER 8

AVAILABLE SERVICES IN INDUSTRIAL HYGIENE

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THE success of our present war effort depends to a large extent upon our industries and our ability to keep every worker on the job by the prevention of sickness and accidents. If disability is incurred, it is necessary to restore the worker to the job as quickly as science, skill, and nature permit. It is obvious, therefore, that the protection and improvement of the health of our vast labor force and the many millions directly and indirectly dependent upon our workers is a responsibility of paramount importance.

In certain localities nearly the entire population is dependent upon industry, so that the health of the industrial workers in such areas forms an inseparable part of the health and welfare of the community. Furthermore, it is now generally conceded that if we are to advance in the development of physical and mental well-being among workers, we must pay attention not only to the working environment but also to factors associated with conditions outside the workplace. It is therefore obvious that the health of industrial workers is a matter of concern not only to industry but to the community at large. Thus, industrial hygiene takes on a new meaning and may be said to be public health applied to gainful workers.

Social programs in recent years have increased our awareness of the role which illness plays in the causation of disability, dependency, and insecurity. In view of the socio-economic implications of illness among workers, and the interdependence of industry and the community in which industry finds itself, it seems that industrial hygiene may offer solutions for many of the problems in public health and social security.

The day is rapidly disappearing when the private physician will only concern himself with the protection of the health of individuals. War has brought full realization that medicine has social and economic aspects, and that the social causes of illness are just as important as the physical ones. It is for these reasons

that the physician must have some knowledge of social and public health problems—problems that he may consider at first glance to be completely unrelated to his work. One of these problems is that of industrial medicine.

The physician should therefore know the various resources in a community which are available to him in the field of industrial medicine. The present discussion attempts to point out these resources and although prime emphasis is focussed upon the governmental agencies concerned in industrial hygiene, other community facilities are mentioned and briefly treated. In addition, there are certain responsibilities which the physician has and contributions which he can make to his community through the field of industrial medicine, which are also mentioned.

DEVELOPMENT OF INDUSTRIAL HYGIENE IN THE UNITED STATES

The development of industrial hygiene in this country has followed very closely critical events in the history of this Nation. It seems almost axiomatic that national crises entailing social and individual hardships and sacrifices often result in progress which would otherwise not have occurred, or at least would have been delayed. This is especially true of industrial hygiene, which was first initiated in World War I. The second upsurge resulted from the demand for social security as a consequence of the depression which began in 1929. It was during the post-depression period that the expansion of the scope of industrial hygiene took place. Today its progress is being given further impetus by the war and by the realization that healthy, efficient workers are absolutely essential for the production of vital war materials.

The development of industrial hygiene methods in industry began with the treatment of traumatic injuries. Gradually the work of the medical department in industry began to extend beyond surgical treatment to the medical and engineering phases of the problem. Such functions as preemployment and periodic physical examinations, job placement, medical and engineering control of occupational diseases, and, more recently, the important problem of illness among workers, commenced to take their rightful place in industry. Where in the past attention was given mainly to the improvement of machinery and processes, today industry is beginning to be concerned with the economic waste resulting from failure to provide protection against controllable or preventable health hazards. Management is beginning to real-

ize that progress can be made in the reduction of lost time from illness by employing the successful methods used earlier in the control of accidents and occupational diseases.

Official Agencies

The work of official agencies in the field of industrial hygiene began largely as the result of certain responsibilities imposed upon them by the passage of workmen's compensation acts and other types of industrial legislation. In the Federal Government are several agencies which are concerned with industrial hygiene problems. The present review will confine itself to a discussion of only a few of the major Federal agencies so concerned.

In the United States Department of Labor are three bureaus and one division vitally interested in this field. These are the *Children's Bureau*, the *Women's Bureau*, the *Bureau of Labor Statistics*, and the *Division of Labor Standards*. The names of these agencies practically define the type of work conducted by each of them. In the Department of the Interior, the *Bureau of Mines* has been concerned with the health and safety of approximately 1,000,000 persons in mining and allied industries. And, finally, in the United States Public Health Service there has been an industrial hygiene unit since the establishment of the *Office of Industrial Hygiene and Sanitation* in 1914. From 1914 to 1935 the Office of Industrial Hygiene and Sanitation, a unit of the Scientific Research Division, was engaged primarily in research work, both in the field and in the laboratory. It was not until early in 1936 that the Industrial Hygiene Office began to take an active part in the organization and development of industrial hygiene units in State and local agencies. For this reason much of the research conducted by the Public Health Service, the Bureau of Mines, and the various bureaus of the Department of Labor, although productive of considerable knowledge concerning industrial health hazards, found little practical application in the States, where, in the final analysis, responsibility lies for safeguarding the health of our workers.

When funds were made available under the Social Security Act for the development and extension of all branches of public health work, the U. S. Public Health Service, through its Office of Industrial Hygiene and Sanitation, inaugurated a program for the purpose of establishing active industrial hygiene work in State and local departments of health.

In undertaking the organization and development of such

work in State and local health departments, many pressing problems had to be surmounted, such as the recruitment and training of personnel, the conduct of demonstration studies in the field in the various States, and the furnishing of consultation services on administrative and technical problems. One of the first undertakings advocated by the Public Health Service was the conduct of preliminary surveys in industry to determine the exact problems of industrial hygiene. Such surveys yielded information on the potential occupational health hazards and on the extent of present-day services for the control of such hazards. The surveys also served as a means for the industrial hygiene administrators to become acquainted with the industries in the area under their jurisdiction. They also served as a means of acquainting industry, labor, and other interested groups in the aims of the health department to develop a cooperative program of health promotion in industry.¹

In the brief interval from 1936 to the present time, in which practically all of our development in official agencies occurred, we have witnessed the establishment of an industrial hygiene service in practically every industrial State in the Union. Today there are 47 industrial hygiene units in 38 States, one Territory, and the Tennessee Valley Authority. Although these units are relatively new in the field, they already have behind them a remarkable list of achievements and have been the means of stimulating the entire program of industrial hygiene.

Nonofficial Agencies

There are numerous nonofficial agencies in the field of industrial health all of which are carrying on active and worthwhile work, and the industrial hygienist cannot afford to overlook the work of these organizations and should develop a plan for utilizing the resources which such agencies have available.

PRESENT ORGANIZATION AND PRACTICE OF INDUSTRIAL HYGIENE, PARTICULARLY IN OFFICIAL HEALTH AGENCIES

U. S. Public Health Service

Early in 1937, the Office of Industrial Hygiene and Sanitation of the Scientific Research Division of the Public Health Service became the Division of Industrial Hygiene, a division of the National Institute of Health; the latter is now the research branch of the Public Health Service. The main function of the Division is the development of means for the protection and improvement

of the health of workers. In January, 1941, the Division of Industrial Hygiene was streamlined in order to meet the emergency situation which was created by the President's national defense program. Figure 3 is a chart depicting the organization of the Division of Industrial Hygiene. It may be seen that it consists primarily of three sections and three units.

The *Research Section* is concerned with studies of a laboratory nature into every type of industrial hygiene problem, espe-

ORGANIZATION CHART

DIVISION OF INDUSTRIAL HYGIENE NATIONAL INSTITUTE OF HEALTH

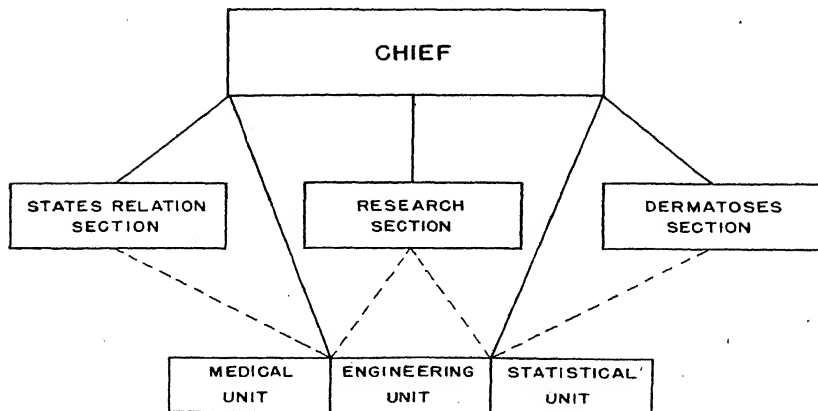


Fig. 3.

cially those dealing with chemical, biological, and physical health hazards. To give the reader an idea of the extent of the scope of the work of the Research Section, one need only mention that more than 100 different problems are being investigated currently. The work of the *Dermatoses Investigations Section* is primarily confined to a study of the occurrence and prevention of occupational skin diseases. The *States Relations Section* has for its main function the promotion of activities designed to put into practical application in industry the knowledge obtained through research. The *Medical, Engineering, and Statistical Units* serve

as a source of supply to the sections in the form of recruitment, training of personnel, and assignment to the sections for duty. Certain independent studies, however, are also carried on by these units, which are in the nature of services and research investigations.

At the present writing the Division of Industrial Hygiene, occupying its own buildings on the National Institute of Health grounds at Bethesda, Maryland, has a staff of more than 200 persons engaged entirely on war problems. The facilities of the Division, with its highly trained staff and complete equipment, are available not only to various Federal and local official agencies, but also to the public at large.

State and Local Health Departments

Today, when there is widespread understanding that the industrial population constitutes the largest, and in many ways the most important section of our population for general health promotion work, it is rather difficult to comprehend the earlier lack of industrial hygiene activity on the part of local official agencies and industrial establishments. Many of our health agencies have limited the scope of their activities. Most of them are still concerned first and foremost with the control of communicable diseases. The results of this emphasis are well borne out by the fact that the communicable diseases today account for only 3 per cent of the mortality in the Nation. However, it is time that health agencies began to shift some of their emphasis toward adult health problems, especially those which account for nearly 80 per cent of all the deaths. These are problems of adult life, such as cancer, heart disease, and other chronic diseases found in the adult population. If illness is used as a measure of needed services, then it would appear that our efforts should be concentrated on the upper respiratory diseases, nonindustrial accidents, and digestive disorders, since these three alone account for more than half of the time lost from disability. It would appear, therefore, that industrial hygiene offers a rare opportunity to do something about our adult health problem.

In developing industrial hygiene services in State and local government, the Public Health Service has based its entire approach on the premise that corrective measures in industry for the protection of the health of workers are accomplished by private effort and by private funds. The important task for any industrial hygiene administration is to see to it that industry

solves its own health problems, with the help of the official agency and others. In other words, the official agency is in a position to help industry to evaluate its problems, to recommend methods for their control, to develop standards of good practice, and to furnish technical guidance and advice on educational programs. The types of services which the official health agency can render to the public in the field of industrial health are varied and quite extensive, but may be briefly summarized somewhat as follows: (1) evaluation of the industrial environment and recommendations regarding needed correction of those conditions found to be detrimental to health; (2) advice to management and medical supervisors as to the relative toxicity of materials or processes, and especially new materials prior to their introduction into industry; (3) consultant services to medical supervisors, private physicians, compensation authorities, and other State agencies regarding illnesses affecting workers; (4) provision of necessary laboratory services of both a clinical and physical nature; (5) assistance in developing, maintaining, and analyzing absenteeism records, and health education programs; and (6) promotion of adult hygiene programs in industry.

In carrying out some of these objectives, industrial hygiene agencies are now employing numerous methods of attack. Perhaps the best way to illustrate the work of the official agencies and how they can be helpful to the industrial physician would be to describe the present practice in some of our States.

Although industrial hygiene utilizes nearly all of the various professional personnel engaged in public health work, the main burden lies on *medical, engineering, chemical, and nursing* personnel. These personnel trained in industrial hygiene methods are in a position to give direct services in the control of the occupational diseases, and are in a position to interpret to industry the need for other services available in the health department which are primarily concerned with other adult health problems. As a rule, the industrial hygiene service is a separate division or bureau within the department of health, although in some States it has been found more desirable to locate the industrial hygiene service in an already existing division or bureau, such as preventable diseases or engineering.

Medical Functions.—In actual practice the various professional personnel constituting an industrial hygiene unit function as a team, each one having certain services to perform. For ex-

ample, the physician should stimulate industry to report all types of disability to the industrial hygiene unit, so that these may be analyzed and the necessary investigations performed to prevent the recurrence of those causes of disability which result in high rates of lost time. The physician is in a position to cooperate with State and county industrial health committees of medical societies, and through such societies and individual physicians to stimulate physical examinations in industry. In addition to evaluating the present health service in a plant, the industrial hygiene physician can give consultation services to private physicians on various occupational diseases and can promote other adult health services in industry through his close contact with the other services in the health department, such as venereal disease, tuberculosis, nutrition, and health education. These are but a few of the activities which an industrial hygiene physician can carry on to definite advantage.

Engineering Functions.—The engineering personnel conduct preliminary surveys for the purpose of determining existing health hazards and later follow these up with detailed studies on such problems as result from exposure to dusts, fumes, vapors, gases, and other airborne toxic materials. The engineers also make studies of ventilation, illumination, evaluate noise and other physical hazards, including safety and general sanitation. By cooperating with the sanitary engineering division, the industrial hygiene engineer is in a position to give advice to industry on such matters as water supply, disposal of sewage and other industrial wastes, cross connections, and many other problems of a general engineering nature.

Chemical Functions.—The chemists in the industrial hygiene unit assist the physician and engineer in the evaluation of toxic hazards and conduct much of the analytical work involved in such studies. This also involves the development of sampling methods and analytical techniques.

Nursing Functions.—Of late, industrial hygiene divisions have added nursing consultants to their staffs, realizing that the nurse in an industrial establishment is the key worker, especially in the promotion of good adult hygiene. The first aims of a consultant industrial nursing program are the promotion of more nursing services in industry, and a better utilization of those services now in existence. The nursing consultant can promote the formation of industrial nursing organizations which can meet to discuss industrial health problems. The consultant nurse can

also advise the plant nurse in such matters as record keeping, sick absenteeism, follow-up, and in general act as a source of information on new developments to the plant nurse. There are numerous functions which a plant nurse should carry on in the interest of health and the official nursing consultant is in a position to interpret these and promote their establishment in the plant.²

Integrated Services

One of the most recent developments in the field of industrial hygiene has been the realization that no industrial hygiene division, no matter how large, can cope successfully with the problems before it unless its program is definitely coordinated with all the other health activities in a health department. By integrating the industrial hygiene activities with other health services in a health department, a complete public health program can be brought directly to industry. These services may be classified into two types: (1) those concerned with personal hygiene, and (2) those dealing with environmental hygiene.

With reference to *personal hygiene*, the following are some of the services which may be given to the industrial worker: (1) communicable disease control, including venereal diseases and tuberculosis; immunization of workers; (2) other preventable diseases, for example, cancer, heart and rheumatism; (3) rehabilitation; (4) dental hygiene; (5) nutrition; (6) mental hygiene; (7) laboratory services of all types; (8) statistical services in connection with morbidity reporting; (9) nursing services in connection with follow-up work on morbidity reporting; (10) public health education; (11) promotion of general medical care programs; and (12) welfare programs.

Some of the services to be given with reference to *environmental hygiene* are: (1) control of working environment; (2) general sanitation (lunchrooms, toilets); (3) water supply; (4) sewage disposal; (5) industrial waste disposal; (6) cross-connection elimination; (7) sanitation of milk and other foods; (8) control of home and recreational environments; (9) housing; (10) swimming pool sanitation; and (11) control of insect-borne diseases.

Integration by Industrial Hygiene Division.—At this point it is appropriate to refer to the manner of integrating industrial hygiene work with the other health services mentioned above. Of late, other divisions of a health department have begun to

realize the opportunity which the industrial population offers for the promotion of public health services other than those concerned with the occupational environment. For example, tuberculosis and venereal disease divisions have become aware of the possibilities which the industrial population offers for mass case finding. The nutritionists have realized that a large segment of the population in any community can best be reached for the promotion of proper nutrition by utilizing the industries in the community. In other words, because of the emphasis which the war effort has placed on industrial hygiene, many agencies, including the various divisions of health departments, have suddenly awakened to the possibilities which the industrial population offers to them for the promotion of their particular specialty.

If we are to bring a total public health program to the industrial worker, a program which he needs if he is to maintain his health and working efficiency, we need the help of all of these other divisions of a State and local health department. But experience has shown us that *all initial contacts with either management or labor should be made by the official industrial hygiene division*. It is this division which has the confidence of both management and labor, by virtue of its having some time in the past rendered a satisfactory service in the control of accident or occupational disease hazards. To the industrial plant, the industrial hygiene personnel represent the health department. It is urged, therefore, that arrangements for the conduct of studies or the rendering of certain health services, such as tuberculosis or venereal disease control, or industrial dentistry, be made through the industrial hygiene division. The industrial hygiene division, therefore, will act as the spearhead and liaison for all the other services available not only in the health department, but perhaps even in the community.

The reason for this method of approach should be quite obvious. However, our observations indicate that sometimes the obvious has been overlooked. In certain States, tuberculosis divisions and venereal disease divisions have gone into industry on their own in an attempt to promote their individual programs. Management in these industries has not been particularly willing to deal directly with these divisions, because they have been accustomed to working with the industrial hygiene personnel and it is their feeling that if any work is to be done in a plant, it should all be done at the same time. In these days when all of our efforts must be concentrated on production, industry should be

disturbed as little as possible. Already Federal and local governmental agencies are entering industry for various reasons, many of which no doubt are legitimate. On the other hand, one can sympathize with both management and labor if one week they are exposed to the services of the industrial hygienists, the next week to the tuberculosis control officer, the following week to the venereal disease control official, and perhaps a month later, the nutritionist. I do not believe it is necessary to carry the discussion any further.

In summary, therefore, it should be understood that it is not the desire of the industrial hygiene personnel to do all the adult health work in a health department. The industrial hygiene division will concentrate on the control of the occupational environment, as it always has, since its personnel has specialized in this particular field of public health. But it should be also the function of the industrial hygiene division to act as the liaison for the other health services in the department, and it should be the industrial hygiene division which makes the necessary initial arrangements whereby these services can be brought to the industrial worker at the plant by the other divisions.

Importance of Integrating Health Services.—The importance of integrating industrial hygiene with other health services in a health agency, and coordinating the activities of all the agencies concerned with industrial hygiene in a community, cannot be overemphasized. In addition to working closely with the other divisions in the central organizations, the industrial hygiene unit should also utilize the other health organizations at the city and county level. We are already witnessing a trend for the decentralization of industrial hygiene activities by the establishment of separate units in some of our municipalities and in one or two large industrial counties. In all such cases the local programs are closely coordinated with the State program. There is no reason why city and county health departments should not begin to make industrial hygiene one of their functions, even though at first these local units may not be able to give a complete service on highly technical problems, especially in the field of occupational disease control. Certainly these local units are in a position to give services in the general health field and can call upon the State organization for the more highly specialized functions.

In connection with the development of industrial hygiene services in local areas, two important factors need emphasis.

First, it is essential that the State organization have a strong industrial hygiene unit with the necessary professional personnel of the types discussed earlier. This is essential if the State agency is to assume leadership and help guide the program locally. Second, it is essential that the local personnel be impressed with the necessity for having the State unit make the industrial hygiene contacts, at least in the earlier stages of the development of the local program. It is believed that both of these points need no further elucidation, since the reasons for them are obvious. In this manner, a wider coverage of industrial hygiene services will be obtained than will ever be possible if the program is attempted merely on a State basis. The industrial hygiene problems in this Nation are too great for any one organization to ever hope to solve by itself. Industrial hygiene administrators should do everything within their means to place industrial hygiene services on the same universally accepted basis that is now true for other health services.

Interdepartmental Relationships

In Federal Government.—In the practice of industrial hygiene, the personnel of the official industrial hygiene agencies have realized for some time the necessity to utilize all the community resources available. Thus, it is recognized that there are other agencies in Federal and State Government that are concerned with industrial hygiene problems. Realizing this fact, the United States Public Health Service has concluded agreements with the Division of Labor Standards of the United States Department of Labor and the Bureau of Mines of the United States Department of the Interior, which form a basis of joint action in the industrial hygiene field. The principle of these agreements is the recognition that each agency has certain functions to perform and that these functions are such that they supplement each other. For example, it is recognized that the United States Bureau of Mines, among its many functions, has the responsibility of conducting investigations of the methods of mining, especially in relation to the health and safety of miners, the appliances best adapted to prevent accidents, and the possible improvement of conditions under which mining operations are carried on. The United States Public Health Service, among other things, is authorized to conduct investigations in industry of a medical and engineering nature, for the purpose of measuring existing health hazards and deter-

mining methods of controlling and eliminating these hazards. Information thus obtained is available to State agencies for their use in administering laws and enforcing rules and regulations designed to prevent and control industrial health hazards. The United States Public Health Service is also authorized to assist the several States in formulating programs for health protection in industry and to extend financial aid for the creation and maintenance of facilities for the service activities of such programs. Since industrial hygiene includes all measures dealing with the protection and improvement of the health of workers, it is distinctly a public health function and, for this reason, the cooperative agreement stipulated that the United States Public Health Service would continue with its studies of the health problems in industry and in the laboratory, and that the United States Bureau of Mines would apply the results of these studies. These two agencies are, therefore, making a joint approach to the problem, working in close cooperation and developing similar relationships in State agencies and others concerned with the protection of the workers in the mining industry. A similar arrangement exists between the United States Public Health Service and the Department of Labor.

In State Governments.—That such arrangements in the promotion of industrial hygiene activities are sound and practicable is amply demonstrated in the excellent relationships which now exist in the several States, and notably in such States as California, Wisconsin, North Carolina, Rhode Island, Idaho, Utah and others. For example, in the State of California, the industrial accident commission furnishes the industrial hygiene service of the State health department with copies of all occupational diseases reportable by law to the former agency. These are investigated by the health department. In addition, the factory inspectors of the commission call upon the industrial hygiene service of the health department to make technical investigations of potential health hazards in industry. Written copies of the results of such investigations are furnished to the industrial accident commission for action, since it is this latter agency which is charged by law to enforce rules and regulations designed for the protection of the health of workers. Practically identical relationships exist in Wisconsin. In this State a physical examination program was recently organized by the industrial commission, in collaboration with the industrial hygiene division of the Wisconsin State Board of Health.³ This plan appears to be an

excellent approach to medical control of industrial health hazards which, coupled with engineering control, should go a long way in the prevention of industrial diseases.

In Idaho, the bureau of industrial hygiene of the State department of health prepares technical codes of safe practices in industry whereby the health of workers may be protected. These codes are adopted after public hearings by the industrial accident commission for enforcement.

In North Carolina, the occupational disease law provides that the industrial commission shall adjudicate the law and shall make investigations of health hazards in certain industries where a silicosis and asbestosis hazard exists. In these industries, pre-employment and periodic examinations are required by law. The industrial commission has designated the North Carolina State Board of Health as its agent and all investigations and physical examinations are conducted either by the State department of health, or under its supervision. Furthermore, the director of the industrial hygiene division of the State department of health of North Carolina is also chairman of the medical board of the industrial commission. This close relationship between the two agencies most concerned with industrial hygiene activities in North Carolina has resulted in an excellent program of control of health hazards in industry.

Relationships between Official and Nonofficial Agencies.—Similar cooperative arrangements are being developed between official industrial hygiene agencies and labor organizations, management groups, universities, State vocational rehabilitation agencies, civilian defense, and especially local health departments.

Responsibilities of Official Agencies

In addition to the cooperative relationships which the official industrial hygiene agency should maintain with other agencies both in the Federal and State government, there are certain responsibilities which are inherent in the practice of industrial hygiene.

Reporting of Occupational Diseases.—For example, in many States, the reporting of occupational diseases is mandatory, such reports as a rule being made to the State health department. Reporting of occupational diseases in this country has been very incomplete. There are many reasons for this, and it is not intended to dwell upon these now, except to indicate that a fair

degree of success can be anticipated only when close contact is maintained between each reporting physician or management and the agency to which occupational disease reports are sent. This implies the necessity for an educational effort on the part of the public health administrators and a service in prompt follow-up of the cases reported. Physicians should be made to realize that they must adopt the same attitude toward the reporting of occupational diseases which now exists with regard to the reporting of communicable diseases. The recurrence of such diseases may be obviated by prompt investigation on the part of a State industrial hygiene service of those conditions in the plant which may be the causative agent. Once this has been established, prompt measures may be taken for the control of the environmental conditions responsible for the diseases.

Formulation of Rules and Regulations.—Another responsibility to be assumed by public health administrators is that dealing with the formulation of reasonable rules and regulations designed to prevent and control occupational diseases. Even if the health agency is not charged by law to establish such rules, it should be in a position to render the necessary scientific consultation services to the State agency so charged. The Idaho law which established a bureau of industrial hygiene in the State health department specifically provides that such consultation services should be given by the industrial hygiene bureau to the industrial accident commission. On the other hand, the Maryland compensation law specifically charges the State health department and Baltimore City health department with the duty of formulating, adopting, and administering rules and regulations designed to prevent and control occupational diseases.

Investigation and Enforcement of Rules.—One of the main functions of an industrial hygiene service, namely, the systematic and prompt investigation of industrial establishments for the purpose of evaluating and controlling hazards to health, has already been discussed. Activities of this kind constitute the major function of divisions of industrial hygiene, and the correction of conditions inimical to health should be the main goal of public health administrators. However, there is one aspect of such investigations in need of clarification. There appears to be a belief among certain individuals and agencies that industrial hygiene divisions in health departments use their findings only for educational purposes, attempting to convince management by persuasion that it would be desirable to effect the necessary

changes to correct hazardous plant conditions. This is true to a great extent, since experience has shown that often much more can be accomplished by persuasive tactics than by the use of force, yet one should not get the impression that health agencies do not resort to force when necessary. Every health department has sufficient power under its basic organic act to take drastic measures in the prevention and control of health hazards. Although the regulation of working conditions is usually a function of labor departments or industrial commissions by specific legislative enactment, health departments have more than sufficient authority in this connection and in certain recalcitrant cases have not hesitated to use this authority.

Assisting in Compensation Cases.—There is one other responsibility which should be assumed by public health administrators, namely, assistance to workmen's compensation agencies in the adjudication of claims. From time to time a compensation commission needs impartial facts which might throw light on a claim. The facts may vary from a health appraisal of the claimant to a study of the working environment where the alleged disease has been contracted. It is believed that public health administrators should be prepared to render such services whenever called upon to do so, unless specific legislation prohibits the use in litigation of results of investigations. It is often claimed that the division of industrial hygiene will lose the confidence of the employer if it testifies to certain findings of a study made in the plant involved in litigation. This argument works both ways, since the facts may also tend to disprove the employee's claim for compensation. Experience has shown that an industrial commission can, in most instances, settle a claim on the evidence submitted and the number of times a commission calls upon a study of the workroom environment or an examination of the worker is limited to a few cases a year. No intelligent employer or employee should have any fault to find with a clear and impartial statement of the facts, based upon scientific inquiry. The proponents for establishing industrial hygiene services within the very agency which adjudicates compensation claims for occupational diseases are on untenable ground, since such an agency is no longer unbiased, being in the unhappy role of judge and prosecutor. The employee, the employer, and the agency adjudicating a compensation claim should welcome the investigation and report of conditions by an impartial agency on an impartial basis.⁴

The present discussion has emphasized the cooperative ap-

proach to industrial hygiene in Federal and State governments by the various agencies interested in and responsible for the solution of industrial hygiene problems. There is a feeling on the part of some individuals that industrial hygiene could be better administered were it under the direction of those agencies also concerned with enforcing certain labor legislation, such as factory inspection, wages and hours of labor, and workmen's compensation laws. It is believed that the present discussion has already indicated clearly that industrial hygiene concerns itself with all the factors affecting the health of workers and, hence, should be administered as an integral phase of a public health program. Public health agencies have always been responsible for investigating and preventing diseases of mankind and this responsibility is shared in this country by National, State, district, county, and city departments of health. The work of the United States Public Health Service in this field for more than a quarter century has already been described. Also the work of the State and local units has been discussed fully, especially that portion dealing with services rendered to other State agencies concerned with industrial health matters. It is obvious that any program for the control of accidents and occupational diseases alone, which necessarily must be the scope of any agency attempting industrial hygiene other than a health department, will definitely fall short of the desired objectives. Since industrial hygiene cannot be separated from other public health activities without a duplication of efforts and funds, it should be obvious that it would be highly undesirable to develop a program in any other organization save that of a health department. To take a health function away from a health department and place it in some other department would, in time, lead to the development of a separate health service in Federal and State agricultural departments for our ten million farmers; a separate health service in Federal and State mining agencies for our million mine workers, and so on. The obvious procedure is to consider health problems as a distinct function of health departments, irrespective of the age, sex, or class of individuals involved.

Activities of Nonofficial Agencies

Earlier in this discussion mention was made that there are numerous nonofficial agencies in the field of industrial health which are carrying on active and worthwhile work. The indus-

trial hygienist cannot afford to overlook these agencies. Although it is not possible, within the scope of the present discussion to mention all such agencies, a few of the most active ones will be treated briefly, and for further details the reader must be referred to an excellent treatment of the subject which appeared in 1942.⁵

Professional Agencies.—The Industrial Hygiene Foundation of America, Inc., has done much for the advancement of industrial health through the study of the occupational diseases. One of the valuable activities of the Foundation is the distribution of bulletins on the medical, engineering, and legal phases of industrial hygiene, and the publication of reviews, abstracts, and bibliographies on matters pertaining to industrial health. The Foundation, in cooperation with the U. S. Public Health Service, has also been active in promoting the study of sick absenteeism among its member companies.

Such agencies as the American College of Surgeons, the National Industrial Conference Board, the National Safety Council, the American Standards Association, the American Society of Heating and Ventilating Engineers, the Illuminating Engineering Society, the National Tuberculosis Association, the American Social Hygiene Association, the Saranac Laboratory for the Study of Tuberculosis, and others, are all taking a deep interest in the subject and have contributed valuable information in their respective fields. The contributions of the American Medical Association have been augmented and coordinated recently through the formation of the Council on Industrial Health. This Council has been particularly active in the development of committees on industrial health among its State and county affiliates, and has attempted to develop programs and set up standards for medical practice in industry.

Industrial Agencies.—Industry, too, has been very active in the field of industrial health and of late has contributed much to the preventive phases of this problem. The National Association of Manufacturers has had a Committee on Healthful Working Conditions for several years. This committee is especially interested in bringing industrial hygiene programs to the small plants which are in no position to carry on such a program of their own accord. Among the trade associations, the work of the American Foundrymen's Association is noteworthy. This particular agency has been active in the development of good practice codes

in the foundry industry, and in the collection of data for the purpose of developing information whereby the objectives of the various codes may be achieved.

Nearly all of the insurance companies, especially those that act as compensation carriers, maintain industrial hygiene personnel and laboratories for the study of existing health hazards and the means for controlling these hazards. Of recent years one or two of the more aggressive labor unions have increased their efforts to promote health among their members.

Other Agencies.—In practically every State are various non-official organizations which can be helpful to the industrial physician and his coworkers in the promotion of industrial health. There are always universities and State medical societies which are engaged on various problems in this field, and, in addition, such organizations as the State nursing societies and local visiting nurse associations which can be utilized for the furnishing of nursing services to industry.

In the field of nutrition there are now State and local nutrition committees, dietetic associations, and local chapters of the American Red Cross which provide nutrition and canteen instruction. Again, in the field of health education, there are various organizations, such as mental hygiene societies, social hygiene societies, tuberculosis organizations, and safety councils, which may be utilized for this purpose.

It is apparent, therefore, that today, more than at any time in the history of the industrial hygiene movement, there are numerous nonofficial organizations active in this field. The important lesson to be gained from all this is that the official agency and the plant official engaged in industrial hygiene should take cognizance of these nonofficial organizations and develop a plan for coordinating their work so as to utilize all the facilities available in a community.

INDUSTRIAL HYGIENE IN THE WAR EFFORT

The groundwork laid by research during the past quarter century and the organization developed during the past six years for the application of this research by industry and by the State, finds this Nation in an excellent position to cope with industrial hygiene problems. Other chapters of this book have handled the various problems confronting physicians in industry under war conditions. It is felt that some knowledge of the present organization developed in official agencies for industrial

hygiene administration in the war effort should be treated in the present discussion.

In 1940, the President created by Executive Order the Office of Defense Health and Welfare Services, which appointed several committees relating to health. One of these, the Committee on Health and Medicine, has a Subcommittee on Industrial Health and Medicine. The duties of this latter committee are to advise on the industrial health and medical aspects of the war effort. The Subcommittee also promulgates policies and suggests means of coordinating all industrial hygiene activities in the Nation. Early in the activities of this committee, it requested the Division of Industrial Hygiene of the National Institute of Health to assume leadership in achieving certain objectives. This was done because of the many years of experience which the Division has enjoyed and also because of its relationship with National, State, and volunteer agencies.

The Division of Industrial Hygiene undertook four major fields of work in the war effort. *First*, it has recruited and trained personnel both for the work of the Division and for States and industry.

Second, it has been giving direct assistance to the War and Navy Departments in the inspection of ordnance plants and other industrial military establishments, as well as certain types of war research. For example, to date the Office of the Surgeon General of the Army has certified nearly 150 industrial military establishments to the Division for inspection. To accomplish this task, the Division maintains mobile units, each consisting of physicians, engineers and chemists, and the necessary supporting personnel at its laboratories. These units make complete surveys and recommendations concerning the improvement of working conditions in the plants, and also conduct certain follow-up studies.

Third, the Division conducts fundamental research at its laboratories on many vital war problems.

Fourth, the Division has been assisting the State units in the work which the State personnel carry on in other war industries. As already mentioned, the Federal Government has no direct function in protecting the health of our civilian personnel, yet it does carry out this responsibility through financial aid, consultation, and leadership, in cooperation with State and local agencies. As a result of such a cooperative program, there are now in existence 45 industrial hygiene units, which are located in States

containing nearly 95 per cent of the Nation's labor force. These units are carrying on a fairly complete industrial hygiene program and last year were able to inspect and give advice to approximately 6000 plants employing more than 2,500,000 workers. In order to assist the State units in carrying out the increased demands placed upon them, the Division of Industrial Hygiene of the National Institute of Health has assigned during the last year some 60 professional personnel to 26 States, the Tennessee Valley Authority, and the District of Columbia.

The War Production Board, realizing the importance which industrial hygiene plays in the War Production Drive, has supported the work of the Division. Early in June, 1942, six War Production leaders, including the Chairman of the War Manpower Commission, issued a joint statement appealing to the management-labor committees to make every effort to reduce accidents and illness in the plant and in the community. The committees were at the same time referred to the Public Health Service for advice on the development of sound health conservation programs. The Division of Industrial Hygiene has placed each committee requesting advice in immediate contact with the local industrial hygiene personnel and has also sent each committee an outline of an industrial hygiene program which could be carried out in the plant and in the community. Furthermore, the War Production Board has established a Section of Industrial Health, Hygiene, and Safety in the Labor Production Division for the purpose of acting as a clearing house and referral agency in the work of the several Federal agencies concerned.

The Division of Industrial Hygiene of the National Institute of Health cooperates with many other agencies both in the Federal Government and in the States, official and nonofficial. Space does not permit a discussion of all these cooperative activities but it is felt that they are somewhat defined in the accompanying chart (Fig. 4). However, it is believed that the cooperative program developed with the Council on Industrial Health of the American Medical Association, because of its pertinence to the present discussion, merits further treatment at this time.

COOPERATION WITH THE MEDICAL PROFESSION AND THE PROFESSION'S RESPONSIBILITY

It has been stated by authorities in industrial hygiene that the major needs are medical and surgical care to effect prompt restoration to health and earning capacity following disability,

the prevention of disability in industry by the proper control of the working environment, and, finally, promotion of health among workers. For those physicians holding positions in indus-

INDUSTRIAL HYGIENE PROGRAM IN THE

WAR EFFORT

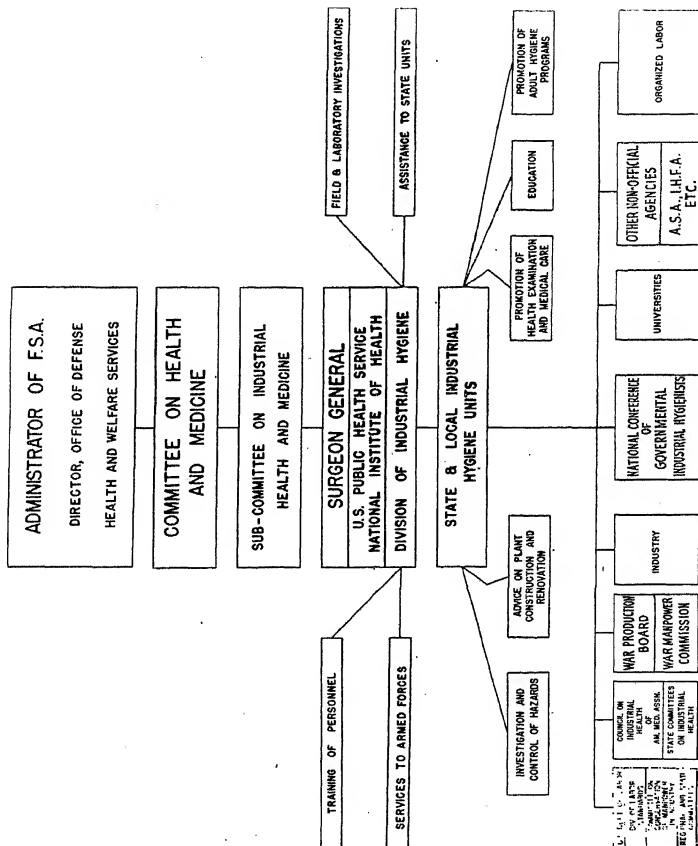


Fig. 4.

try, and especially those completely responsible for furnishing programs of industrial health maintenance, the Council on Industrial Health of the American Medical Association has suggested a definite program.⁶ Although it is true that the official industrial

hygiene agency can serve as a spearhead for bringing health services to the worker, it is also true that 62 per cent of the workers when in need of medical attention have to turn to the private practitioner. It is for this reason that the physician individually and through his medical society should give serious consideration to his responsibility in the field of industrial hygiene. It is for this reason that there should be the closest possible cooperation between the medical profession and the official industrial hygiene agency.

The Council on Industrial Health of the American Medical Association has been very active in stimulating physicians individually and through medical organizations to contribute to the health of industrial workers. The Council has fostered the formation of committees on industrial health in State and county medical organizations, and has outlined a program for such committees. It is not possible to describe all of the ways in which State and local medical societies and the official industrial hygiene agencies can collaborate to their mutual benefit, but it is desirable to discuss several programs now in effect in some States and to suggest some of the more important steps which need to be taken to bring about a closer working relationship.

For example, in Iowa a series of special institutes on industrial health, sponsored by the Speakers' Bureau, the Committee on Industrial Health of the Iowa State Medical Society, and the Iowa State Health Department, were held in several Iowa cities. These institutes, which drew nearly 1200 practicing physicians and industrial managers, were very favorably received, and are now being emulated in other States. In some States the medical society has been able to strengthen the work of the official industrial hygiene agency through its interest and effort in this direction. For example, in New Jersey the Committee on Industrial Health of the State Medical Association was instrumental in arranging for the assignment of personnel to the New Jersey State Department of Health by the Division of Industrial Hygiene of the National Institute of Health, thereby inaugurating an industrial hygiene program in that State. The program carried on by the Committee on Industrial Health of the Connecticut State Medical Society has been one of the bright spots in cooperative work of this nature. In fact, it is our feeling that the Connecticut program could very well be imitated elsewhere, since it has been productive of fine work in the field of industrial medicine and hygiene.

These and similar activities indicate progress toward a closer

working relationship between the medical profession and existing industrial hygiene agencies. However, there are many other ways in which the practicing physician, either as an individual or through the State medical organization, can contribute to industrial hygiene.

Thus, it is pertinent once again to stress the importance of the private physician familiarizing himself with the various occupational diseases, so that he can recognize such diseases more readily in the course of his practice. In view of the fact that a man's occupation may have a real bearing on his health, it is also essential that the physician obtain an accurate and detailed occupational history of his patient. Such an inquiry may often necessitate investigating the patient's working environment, or at least obtaining information on this point from the proper plant officials, as well as from the patient himself.

This aspect of the problem brings attention to the need for the State industrial hygiene unit to request the managers of plants which are being surveyed to invite their physician, and particularly the one on call, to accompany the representative of the industrial hygiene unit through the plant during the investigation. Such a plan will serve as a stimulus to the physician, particularly to the physician on call, or the part-time physician, who often does not have the time or the incentive to familiarize himself with working conditions in the plant, and should result in a more efficient and intelligent medical service.

One other aspect of the occupational disease problem should be stressed. That is the necessity for reporting occupational diseases to the official agency which is responsible for the control of such diseases. Although this was mentioned earlier in this discussion, it bears repetition.

The medical profession should also utilize to the fullest extent the services which are provided by the official industrial hygiene agency, and through it the facilities of the entire health department. The industrial hygiene unit, as already indicated, can give consultation services to the medical profession regarding needed corrections of environmental conditions in the plant, the toxicity of materials and processes, occupational diseases, and general illnesses affecting workers. It has available the necessary laboratory services for both clinical and environmental investigations, and by virtue of being an integral part of a health department, is in a position to bring general public health services to a plant.

In closing this discussion, it may be well for industrial phy-

sicians and management to ponder over the necessity for developing a brand new philosophy on the entire subject of industrial hygiene. This change of philosophy may be likened to the change which occurred early in this century, when industry made up its mind that it was cheaper to prevent accidents than to pay for them. Industrial medical practice should consider that its duty in a plant should go beyond the preemployment and periodic physical examination, and the treatment of occupational diseases and plant injuries, and that it has another duty which is a very important one; namely, to keep the worker well and on the job. Even though the bulk of the lost time may be attributed to disability incurred off the job, no progress will be made unless management considers that something has to be done about such off-the-job disabilities. This is especially true now that there is such a shortage of labor. It should be management's business, and management will find that it is good business, to take an interest and a responsibility in each worker as regards such items as general health, home and community facilities, medical care, nutrition, recreation, and other factors which promote good health.

Any effective program, therefore, must take all of the factors mentioned into consideration. Action must be directed toward the development of a high level of health and morale among the working population. This involves not only health protection and supervision at the plant, but the coordination of all health and medical resources in the community.

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PART II

PREVENTION AND CONTROL OF DISEASE IN INDUSTRY

SECTION I

CHAPTER 9

THE PROBLEM OF OCCUPATIONAL DISEASE

W. C. Dreessen, M.D.

INTRODUCTION

CLAIMS paid for occupational disease under workmen's compensation amount to from 1 to 3 per cent of the amount paid for industrial accidents. This cost comparison, however, does not give the complete picture of their relative importance. In speaking of occupational diseases one ordinarily thinks of such diseases as occupational dermatitis, lead poisoning, and silicosis. In this country these three groups of diseases constitute the most important occupational diseases, with respect to both number of cases receiving compensation and total cost of compensation per case.

Based on a year's experience of one State,¹ the compensation costs of individual cases are generally lowest for dermatosis cases (averaging about \$50 per case) and highest for silicosis cases (averaging about \$5,000 per case); lead poisoning occupies a middle position with an average cost per case of about \$150. These differences in costs are related to the degree of permanency and duration of the disability. These three diseases bid well to continue to lead the list in the changeover from peace to war-time production.

The liability of the employer without proof of fault is the essential principle upon which workmen's compensation is based. Within the limitations of wording or mode of administration

of the compensation laws, the provisions common to these acts are the giving of prompt medical care, and payment of monetary benefits, at the cost of the employer without regard to the question of negligence, to an injured or occupationally ill employee or to his dependents in case of death in line of duty.

Under the workmen's compensation laws,² the three common law defenses, namely contributory negligence, the fellow-servant doctrine, and the assumption of risk, are no longer available to the employer. Consequently, the burden of economic loss and waste due to personal injury has been shifted from the employee to industry and thus has been made an item in the cost of production ultimately to be borne by the consumer.

Occupational diseases were not specifically covered in the original State workmen's compensation laws. Even as recently as 1920, compensation for such diseases was provided in only seven jurisdictions³ in the United States—California, Connecticut, Hawaii, Massachusetts, North Dakota, Wisconsin, and the Federal government. Occupational diseases introduced more complex factors in the administration of law than were encountered with industrial accidents.

Occupational Disease Coverage in Various Jurisdictions

There is a lack of nationwide coverage for occupational disease.* Although all of the 48 States, excepting Mississippi, have legislation providing for compensation of industrial injuries, only 25 States have laws providing compensation for occupational disease. The Federal government also provides compensation for such diseases under compensation laws for its civil employees, longshoremen and harbor workers, and for such diseases arising from private employment in the District of Columbia. Compensation is provided for all occupational diseases or for certain specified ones in the jurisdiction shown in the accompanying list. This list also contains the name and address of the agency administering workmen's compensation in the respective State or jurisdiction. Copies of compensation legislation and the rules and regulations of the administrative agency pertaining to the jurisdiction in which he is practicing should be readily available to the industrial physician.

* The discussion in this chapter has been limited to occupational diseases. The reader should not overlook compensation aspects of industrial accidents.

LIST OF JURISDICTIONS IN WHICH OCCUPATIONAL DISEASE IS COMPENSATED
AND THE NAME AND ADDRESS OF THE ADMINISTRATIVE AGENCY

Arkansas	Workmen's Compensation Commission Rector Building, Little Rock
California	Division of Industrial Accidents and Safety State Building, San Francisco
Connecticut	Board of Compensation Commissioners 54 Church Street, Hartford
Delaware	Industrial Accident Board Ninth and Market Streets, Wilmington
District of Columbia	D. C. Workmen's Compensation Act Seventh and E Streets, N. W., Washington
Hawaii	Department of Labor and Industrial Relations Bureau of Workmen's Compensation Honolulu
Idaho	Industrial Accident Board Boise
Illinois	Industrial Commission 205 West Wacker Drive, Chicago
Indiana	Industrial Board 404 State Capitol, Indianapolis
Kentucky	Workmen's Compensation Board Frankfort
Maryland	State Industrial Accident Commission Equitable Building, Baltimore
Massachusetts	Department of Industrial Accidents Statehouse, Boston
Michigan	Department of Labor and Industry 630 State Office Building, Lansing
Minnesota	Industrial Commission 137 State Office Building, St. Paul
Missouri	Workmen's Compensation Commission State Office Building, Jefferson City
Nebraska	Workmen's Compensation Court State Capitol, Lincoln
New Jersey	Bureau of Workmen's Compensation Wallach Building, Trenton
New York	Department of Labor Division of Workmen's Compensation 80 Centre Street, New York
North Carolina	Industrial Commission Raleigh
North Dakota	Workmen's Compensation Bureau Bismarck
Ohio	Industrial Commission State Office Building, Columbus
Pennsylvania	Bureau of Workmen's Compensation Harrisburg
Puerto Rico	Industrial Commission San Juan
Rhode Island	Department of Labor Division of Workmen's Compensation Providence

LIST OF JURISDICTIONS IN WHICH OCCUPATIONAL DISEASE IS COMPENSATED
AND THE NAME AND ADDRESS OF THE ADMINISTRATIVE AGENCY (*Cont.*)

Utah	Industrial Commission State Capitol, Salt Lake City
Washington	Department of Labor and Industries Olympia
West Virginia	Workmen's Compensation Department Charleston
Wisconsin	Industrial Commission 1 West Wilson Street, Madison
United States	U. S. Employees' Compensation Commission 285 Madison Avenue, New York, New York

Definition of Industrial Disease

Briefly stated, an occupational disease is an affliction due to a specific industrial health hazard. Legal connotations, however, tend to either limit or extend the number of diseases embraced by this definition. There are two schools of thought on the subject of occupational disease legislation and administration. Thus, one school holds that a disease to be occupational must "arise out of and in the course of employment." In other words, it is something characteristic of the employment and not a hazard to which the public is generally exposed. Such diseases are fairly well exemplified by those listed in certain schedule laws (e.g., poisoning by lead, arsenic, and mercury, and silicosis).

The other school holds that any disease contracted by a worker, which arises out of employment or out of an incident of employment and yet not necessarily characteristic of employment, is an occupational disease. This viewpoint provides for the inclusion of such diseases as pulmonary tuberculosis and malaria. Thus, nurses and internes have received compensation for pulmonary tuberculosis contracted in the course of their work in tuberculosis sanatoria, and a railroad laborer is compensated for malaria contracted in railway section work.

The definition of occupational disease has always been found to be very difficult.⁴ Much has been written on the subject. One of the commonly quoted definitions is that of the Rhode Island law which states that, "The term 'occupational disease' means a disease which is due to causes and conditions which are characteristic of and peculiar to a particular trade, occupation, process, or employment."

In many instances it is seen that the "compensable diseases" are the "occupational diseases." Brahdys's comments⁵ on this point, however, are pertinent: "When physicians differentiate

between the terms, 'occupational' and 'compensable,' they recognize a boundary separating their medical field from the legal administrative field. Physicians—and only physicians—can decide whether a disease is occupational. Lawyers and administrators, but never physicians, must decide if an occupational injury is compensable according to the law of that State."

Comparison of Schedule and General Coverage Laws.—In some of the State compensation laws, no clear-cut distinction is made between "occupational disease" and "industrial injury." This is probably related to the fact that before administering agencies had experience in compensating occupational disease, an attempt was made to provide coverage for such diseases by amending definitions of the term "injury" to include occupational diseases in some form, either by listing a few of them or by the use of broad language.⁶ Two general terms are thus ordinarily applied to laws providing compensation for occupational disease. These acts are referred to as (1) *schedule* or limited coverage laws, and (2) general coverage or *blanket* laws.

Under the schedule laws, the specific compensable diseases are listed and briefly described. This type of coverage holds in Arkansas, Delaware, Idaho, Kentucky, Maryland, Michigan, Minnesota, Nebraska, New Jersey, North Carolina, Pennsylvania, Rhode Island, Utah, West Virginia, and Puerto Rico.

In other jurisdictions the law provides compensation for any disability arising from an occupational disease without attempting to name it and is the law in California, Connecticut, District of Columbia, Illinois, Indiana, Massachusetts, Missouri, New York, North Dakota, Ohio, Washington, Wisconsin, and Hawaii.

The language of some general coverage acts adds qualifications to the effect that ordinary diseases of life to which the general public is exposed outside of the employment shall not be compensable, except where the said diseases follow as an incident of an occupational disease. These general coverage acts having a statutory definition of the term "occupational disease" are referred to as *definitive general coverage laws*.

Provisions of Compensation Laws

The industrial physician should know which occupational diseases are compensable in his State. He should also familiarize himself with the administration of the law so that his reports and opinions will convey the proper meaning. Besides the type

of coverage referred to above, the laws include such provisions⁷ as scale of compensation, insurance features, limitations as to type of employment, number of employees, medical benefits, extraterritorial provisions, reporting of occupational diseases, medical boards, accrued liability, and waiver or second-injury provisions.

Contrary to industrial accidents which can usually be related to time and place, certain occupational diseases take years to develop and hence as a point of reference the day when disability or incapacity begins is usually recorded as the date of injury.

Workmen's compensation laws are designed primarily to furnish the occupationally ill worker with medical care and monetary benefits during the period of his disability or money payments to his beneficiaries in case of death. Except in some States having a State insurance fund and those States where employees may contribute, the cost of compensation is borne almost entirely by the employer. *Compensation* for loss of wages usually runs from 50 to 70 per cent of the employee's average wage with minimum and maximum amounts usually specified. Most States provide a certain specified period of time immediately following disability, during which compensation shall not be paid. This period varies from one to 14 days, but is 7 days in most States. Claims must be filed within certain time limitations. Failure to provide full compensation for wage loss is meant to be an incentive for the temporarily disabled worker to return to work as soon as possible and to preclude malingering. *Medical costs* are not borne by the worker in most of the States, but maximal limits as regards period of time and cost, or both, of this service are usually specified. According to Newquist,⁸ "the acts of 23 States and of the Federal government do not limit the period for medical benefits other than by qualifying terms such as 'reasonable,' 'reasonable time,' during 'temporary disability,' etc. The stated time limits for medical service range from 2 weeks to 1 year and the limited amounts for medical benefits range from \$100 to \$1,600. Because of the uncertainties and great potential burdens associated with the present occupational disease situation, a few States have seen fit to limit the medical responsibilities of employers for treating workers with such diseases, particularly silicosis or asbestosis."

Financing the payment of compensation benefits is usually accomplished through insuring the employer's liability by *insurance* with a private company, by State fund, or by self-insurance.

The employer is allowed to insure in a private company in most States, but a few States have exclusive State funds. Whether or not an employer may elect or be compelled to carry insurance varies according to jurisdiction.

Depending on the degree of incentive offered employers to accept the benefits and burdens of the compensation law, these laws may be classed as *compulsory* or *elective*. According to Dawson,³ "a compulsory law is binding upon every employer and employee within its scope; there is no choice. Under an elective act, employers and employees have the option of either accepting or rejecting the act. But in case the employer rejects, the customary common-law defenses in personal injury litigation are usually removed, while if the employee rejects, the workmen's compensation principle of liability of the employer for work injuries without regard to fault is not applicable to an action for damages."

Agricultural and domestic workers are excluded from benefits of compensation laws in most States. Among the exceptions are Arizona, California, Connecticut, Illinois, Kentucky, Minnesota, New Jersey, New York, Ohio, South Dakota, Vermont, and some of the territories of the United States. Casual employees are also usually excluded. Employers are also exempt if they employ fewer than a specified number of workers. Special conditions are provided in certain jurisdictions for covering hazardous and public employments as well as disability incurred outside of the State. The limiting provisions relating to silicosis deal with (1) period of employment and exposure within the State, (2) filing of claims, (3) time within which death must occur in compensable fatal cases, and (4) deductions from death benefits.

Some States have included penalty provisions for false statements as a responsibility of the employee. If as an applicant for employment the employee falsely represents that he has not suffered from an occupational disease which subsequently causes disability or death, his compensation is forfeited.

The term *accrued liability* has been used to describe potential compensation claims for occupational disease which existed prior to the enactment of occupational disease legislation. It is particularly characteristic of silicosis, a disease which requires years for the pathologic process to mature and cause disability. It is an accrual of injuries sustained during previous years of employment. In some acts the last employer of the victim of disease (e.g., silicosis) is held fully liable for compensation. At

the National Silicosis Conference (1938), the Committee on the Economic, Legal, and Insurance Phases of the Silicosis Problem⁹ felt that such accrued liability should be at least in part recognized as a public liability. This conclusion is related to lack of nationwide occupational disease coverage. Because of interstate movement of people, States having or planning silicosis coverage fear that they will become the dumping ground for the accrued liability of other jurisdictions.

With the passage of compensation laws making employers responsible, preemployment examinations were adopted by employers to screen out physically defective workers. As Dawson⁸ points out, this adverse effect upon the employment of handicapped workers was an unforeseen consequence of these laws. Employers considered the increased risk of loss a good cause for refusing employment. To remedy this injustice and to minimize the difficulty which partially disabled workers have in securing employment, some of the States created special "second-injury" funds and amended the compensation act to provide that in case of a second major disability the employer should be held liable only for the second injury considered separately. The disabled employee, however, is compensated for disability resulting from the combined injuries. Statutory provisions for second-injury funds are included in the laws of Arkansas, District of Columbia, Hawaii, Idaho, Illinois, Massachusetts, Minnesota, New Jersey, New York, North Carolina, North Dakota, Ohio, South Carolina, Utah, West Virginia, and Wisconsin, and also in the Federal Longshoremen's Act.

In the absence of second-injury funds, *waivers* and *limited disability* have been used to meet the issue. These procedures find application particularly in dealing with accrued liability of silicosis. Speaking of waivers, Kessler¹⁰ states: "These waiver clauses take cognizance of the fact that the workmen's compensation law may be an obstacle to employment. They aim to permit the workman to exchange a right for a benefit he may prize more highly.* Though it would be possible to safeguard the employer from the suit of a workman who had waived compensation, to allow the workman so to waive this right is open to various objections and abuses. It might become possible, for instance, for employers to require *all* persons with *any* physical disability to sign waivers as a condition of getting employment. . . . In practice, waivers are restricted or prohibited in most jurisdictions." Where restricted, they are issued in accordance with regulations

of the agency administering the compensation law. Under limited disability plans the disabled worker may be compensated only for later injury, or the decreased earning power of the handicapped worker is used as a basis of apportioning compensation. In general, it seems that with reference to handicapped workers an exception should be made to the theory of workmen's compensation which makes industry bear the full burden of responsibility for industrial disabilities and have the government assume part of the burden.

CLINICAL DESCRIPTION OF DISEASES OF PRESENT IMPORTANCE

Classification of Diseases or Conditions

Dublin and Vane¹¹ classify occupational hazards as follows: (1) abnormalities of air pressure, (2) abnormalities of temperature and humidity, (3) dampness, (4) defective illumination, (5) dust, (6) infections, (7) radiant energy, (8) repeated motion, pressure, shock, etc., and (9) poisons.

Major Groups of Occupational Diseases.—A review of various compensation laws subscribing to schedule coverage shows that the specified occupational diseases fall into six or so major groups when classified according to causative agent. Thus, under *toxic metals or metalloids* may be listed poisoning caused by arsenic, zinc (brass), cadmium, lead, manganese, phosphorus, radium, and mercury; under *dusts* are listed pneumoconiosis and/or silicosis with or without tuberculosis and asbestosis with or without tuberculosis; under *gases, vapors, and fumes*, poisoning caused by hydrogen fluoride, nitrous fumes, sulfur dioxide, carbon disulfide, hydrogen sulfide, hydrogen cyanide, carbon monoxide, nickel carbonyl, halogenated hydrocarbons, methyl alcohol, benzene, and nitro and amino derivatives of gasoline, benzene, and phenol; under *occupational skin hazards*, chrome ulceration or dermatitis, infection or inflammation of the skin or eyes due to oils, cutting compounds, lubricants, dusts, liquids, fumes, gases, and vapors, epitheliomatous cancer or ulceration of the skin or surface of the eye due to pitch, tar, and bitumen, and dermatitis venenata; under *infectious agents* may be listed such diseases as anthrax and glanders; and under *physical agents* may be listed compressed air illness, radioactive substances, cataract, and impaired hearing caused by noise.

War Industries and Occupational Disease.—With few exceptions, the serious and prevalent occupational diseases of prewar days may be anticipated as being the sources of difficulty in war-

time industrial production. Cunningham¹² of Canada has given us some idea of what we may expect from the changeover to war production. He states that the number of cases of occupational disease have increased in the Dominion, but up to the present they have come from increased exposure to common substances rather than from new processes.

Predominance of Industrial Poisoning.—Exclusive of dermatoses, industrial poisonings make up the majority of the occupational diseases. The progressive industrial physician moreover recognizes the need of studying the toxic properties of new substances or chemicals prior to the establishment of a new industrial process. He is aware of the fact that absorption of metals and their compounds does not as a rule induce the same reaction or degree of action in the body as the metal or its compounds when used for therapeutic purposes. In other words, industrial intoxications are characteristically chronic in contradistinction to acute poisonings of usual medico-legal importance. When acute, disability ordinarily occurs on the day of exposure and the disease entity is then usually considered an accident. The portals of entry for industrial poisons are (1) by inhalation, (2) by mouth, (2) through the skin, and (4) through the subcutaneous tissues. Broadly speaking, the respiratory route is characteristic of most industrial poisons.

Medical Questions Arising.—Because an occupational disease is related to the personal activity of the worker and is of the nature of the inevitable consequences of a given type of work, medical questions are bound to arise in the settlement of occupational disease claims.¹³ Besides the nature, extent, and duration of disability, questions of etiology and differential diagnosis need to be established. To solve these questions the industrial physician should have a clear conception of the time factor in the evolution of these diseases. Related to this time factor is a latent period without disability somewhat analogous to the incubation period of infectious diseases. In silicosis, for instance, it may require the passage of from 2 to 25 years of industrial dust exposure before the disease manifests itself clinically in a given worker. Needless to say, it is important to have a record of the nature of exposure in different types of work in the form of an *occupational history*. This may be a time-consuming inquiry, particularly in the case of a miner who has worked in many different mines over a period of 30 years or so, or in the instance of a worker potentially a victim of metal poisoning from whom

the physician endeavors to learn the circumstances, such as the lack of ventilation, chemicals involved, and nature of the work process, which have precipitated the toxic episode. Other steps in diagnosis make the same demands on the physicians's acumen as other disease entities.

In the following pages certain selected occupational diseases, which are manifested by systemic reaction, will be briefly discussed. A chapter on occupational dermatoses appears subsequently. An endeavor has been made to present an epitomized account of the most significant occupational diseases.

Lead Poisoning

Industrial Uses of Lead.—About 150 industrial occupations entail a possible lead exposure. The principal hazards¹⁴ occur in:

Storage battery manufacture	Printing industry
Paint industry	Welding and riveting, in enclosed spaces, steel painted with red lead
Application of paints	Rubber manufacture
Enameling of such articles as bath tubs	Lead ore mining
Pottery glazing	Tetraethyl lead manufacture, or cleaning tanks in which ethyl gasoline has been stored
Reclamation of lead from junk metals	
Lead arsenate manufacture	

Among the most commonly used lead compounds are lead carbonate, lead chromate, red lead, lead sulfate, litharge, lead acetate, lead arsenate, and tetraethyl lead.

Symptoms.—Lead absorption into the tissues is cumulative in the sense that a part of the relatively small daily doses, individually insignificant, which is absorbed each day, is not eliminated promptly. When physiologic tolerance is exceeded, symptoms and disability occur. Lead enters the body in industrial work principally through the respiratory tract. Organic lead compounds, for example, tetraethyl lead, may enter through the unbroken skin. The maximal permissible concentration for lead is 1.5 mg. per 10 cubic meters of air, and this quantity may be considered as a daily dose which should not be exceeded if disability is to be prevented.

Industrial lead poisoning ordinarily occurs following prolonged exposure to lead or its compounds. Classified on the basis of systems, the three more or less distinct clinical types of lead

poisoning* seen currently among American industrial workers are alimentary, neuromotor, and encephalic. Some cases show a combination of two or more of these principal clinical manifestations.

The *alimentary type* is the most frequent in occurrence. It is characterized by abdominal discomfort or pain which culminates in frank colic in the most severely affected cases. Obstinate constipation is occasionally preceded by a brief period of diarrhea. Among the other complaints in this type of case are loss of appetite, nausea and vomiting, metallic taste, lassitude, insomnia, general weakness or asthenia, arthralgia, myalgia, irritability, dizziness, and headache. Accompanying these symptoms may be the following signs: ashen pallor, lead line on gums, pyorrhea, malnutrition, abdominal tenderness, basophilic stippling, reduced hemoglobin and red blood cell count (but may be within normal limits), slight albuminuria, and elevation of lead content of blood and urine. When a typical episode of colic is in progress, the patient is obviously in agonizing pain, bathed in cold sweat, has gray-green pallor, and is likely to be doubled up with hands pressing upon his abdomen. During a spasm the abdomen has a board-like rigidity. Between spasms, the abdominal pain is usually relieved by firm pressure. The pain of lead colic is usually promptly relieved by intravenous administration of calcium chloride or calcium gluconate.

The *gingival lead line*, if present, will show up as finely punctate bluish-black deposits in the gum tissue. It should not be confused with the congestion of chronic gingivitis, discolored calculus on the tooth surface, or the normal pigment deposits observed in the gums of Negroes and other dark-skinned races. The effects of congestion can be overcome by pressure with a transparent applicator such as a glass slide.

In the *neuromuscular type*, the chief complaint arises from weakness, perhaps the paralysis (wrist drop) of the extensor muscle groups of forearm and hand. The paralysis may be unilateral or bilateral. When unilateral, it is likely to affect the arm most used. If a lower extremity is involved, foot drop may be present. Gastro-enteric symptoms, though not absent, are less disturbing. Arthralgia, myalgia, aching, and stiffness of muscle groups are likely to be more severe than in the alimentary type.

* The presentation of the discussion of the clinical manifestations of lead poisoning follows a section (to be published) of a report prepared by the Committee on Lead Poisoning, American Public Health Association.

Headache, vertigo, insomnia, and disturbed sleep are likely to be prominent symptoms. True palsy is uncommon today; it is usually the result of prolonged and severe lead exposure, and clinical history may give evidence of repeated episodes of intoxication of milder type.

Lead encephalopathy is the most severe but fortunately the rarest manifestation of lead poisoning. In the industrial worker it follows rapid, heavy lead absorption. Certain organic lead compounds, such as tetraethyl lead, are absorbed rapidly (through the skin as well as other portals of entry) into the body and especially into the central nervous system. With these compounds, encephalopathy is the rule. Comparable concentrations of lead are absorbed into the brain from inorganic lead compounds only when the workplace is heavily contaminated with lead vapor, fume, or dust.

Lead encephalopathy begins abruptly and is characterized by signs of cerebral and meningeal involvement. The patient may be in a heavy stupor at the onset and go into coma, with or without convulsion, and die. Excitation, confusion, and mania occur less frequently. Headache, dizziness, insomnia, and somnolence are symptoms in cases recovering and of shorter duration.

The cerebrospinal fluid may be increased in pressure and show slight increase in cellular elements and globulin.

Laboratory Findings.—Laboratory findings supplement the clinical findings and are of considerable assistance in differential diagnosis. They should not be expected to yield the diagnosis.

Evidence of the effect of lead on the hematopoietic system is ascertained by a study of the blood picture. Basophilic granulation or stippling of erythrocytes should be ascertained in quantitative terms and related to an established normal standard. According to Mayers,¹⁶ abnormal cell morphology and abnormal cells (including nucleated erythrocytes) are more characteristic than stippled cells and polychromatophilia of lead anemia, even in such cases in which the hemoglobin is as high as 80 per cent and there is a red blood cell count of 4 million.

The blood of normal North Americans has an average lead content of 0.03 mg. (range 0.01 to 0.06) per 100 gm. of whole blood.¹⁵ Normal urinary lead values average 0.03 mg. per liter with values ranging from 0.01 to 0.08 mg. per liter or ranging from 0.005 to 0.12 mg. per liter, depending on the size of the sample submitted for analysis. The finding of abnormal quantities of lead in blood and excreta means only abnormal lead ab-

sorption and hence points to the existence and severity of lead exposure.

Lead intoxication¹⁵ occurs rarely if the *mean urinary* lead concentration of representative groups of workers is kept below 0.10 mg. per liter, and if individual results are generally below 0.15 mg. per liter and very rarely in excess of 0.20 mg. per liter. The upper limit of safety for the concentration of lead in the blood lies somewhere between 0.05 and 0.07 mg. per 100 gm. The blood levels in frank cases of lead intoxication are usually considerably higher (0.09 to 0.30 mg. per 100 gm. of whole blood). Samples for chemical analysis to determine lead content of blood or excreta should be obtained near the height of an acute episode. Extreme care is necessary to avoid contamination from the time of taking the sample until it is completely analyzed.¹⁷

Differential Diagnosis.—The *alimentary type* must be differentiated from such conditions which may require surgical intervention, as acute appendicitis, acute cholecystitis and cholelithiasis, perforated peptic ulcer, intestinal obstruction, and acute pancreatitis. Neglect of a surgical condition is far more serious for the patient than giving undue weight to apparently significant lead exposure. In such cases "it is better to err on the side of surgical exploration." Jaundice in lead poisoning is rare today. Leucocytosis, and abnormal differential count, would favor inflammatory lesions. Hematuria is very rare in lead colic cases. Intestinal obstruction is difficult to differentiate, but if stippling is absent lead colic may be eliminated. The medical history will afford material differential points and it is particularly helpful in cases of peptic ulcer or coronary thrombosis.

With respect to *lead neuropathy or encephalopathy*, neurologic changes induced by viruses, infections, arsenic, malnutrition, and alcoholism must be ruled out.

Treatment.—Treatment may be briefly summarized as follows: (1) discontinue the worker's exposure to lead, (2) treat the acute episode with large doses of calcium and calcium-rich diet, (3) later induce catharsis, (4) during convalescence active deleading procedures¹⁸ may be instituted, although some investigators assert that the body will gradually rid itself of excess lead if lead exposure has ceased, and (5) treat cerebral symptoms and sequelae palliatively.

Generally speaking, on recovery from acute lead poisoning, the worker may return to his former occupation provided the lead exposure responsible for his disability has been brought

under control or eliminated. Otherwise, it will be necessary to place him in a job entailing no exposure.

Periodic occupational examinations or check-ups to detect early evidence of dangerous lead absorption should be performed on all workers exposed to a lead hazard, but their frequency must be related to the problem at hand. Workers who are exposed to less than 1.5 mg. of lead per 10 cubic meters of air need not be examined regularly more than once or twice a year, but in extremely hazardous exposures and in young employees it may be necessary to raise this frequency to every fortnight.

Metal Fume Fever

Metal fume fever is an acute transient illness often referred to as brass foundry's ague, metal shakes, oxide chills, brass chills, galvo, and zinc oxide fever. Although at one time the disease was thought to be caused exclusively by zinc,^{19, 20} it is now known to be produced by other metals, for example, cadmium, lead, manganese, mercury, and magnesium. It follows the inhalation of rather heavy concentrations of finely dispersed metal fumes, usually in the form of oxides. Then, under certain circumstances, toxic proteins or albuminates of the metals are said to be formed which produce a severe transient febrile reaction resembling protein shock in nature and symptomatology.

Symptoms.—A few hours after exposure,^{21, 22, 25} the nose, throat, and substernal region feel dry and sore, burn, and give rise to a dry cough. A feeling of constriction in the chest, headache, and lassitude may be complained of and sometimes nausea and vomiting occur. Symptoms at this stage are similar to the prodromes of an acute respiratory infection. Within one to several hours, the symptoms become aggravated, the headache becomes worse, vision may become blurred as chilly sensations begin to appear, and the victim usually takes to his bed. Shivering or trembling rapidly increases into a more or less severe rigor which may last from $\frac{1}{2}$ to 2 or 3 hours. Fever and leucocytosis²³ not uncommonly accompany and follow the chill. Myalgia and arthralgia are also usually present at this stage. The symptoms associated with the chill end almost by crisis and are followed by profuse perspiration. Considerable prostration usually follows an attack but by the next morning recovery is usually complete. An entire attack seldom lasts longer than from a few to 20 hours, and for this reason compensation is rarely claimed.

New workers and employees upon their return to work fol-

lowing a holiday or lay-off are particularly susceptible to an attack. Workers become "immunized", but this artificial immunity lasts only about 5 days.³⁶ The illness is also more likely to develop in winter and is aggravated by chilling the body. If symptoms persist for more than a day, it is necessary to look to lead, manganese, cadmium, and arsenic as specific causes. Malaria, influenza, tuberculosis, leukemia, Hodgkin's disease, acute bronchitis, onset of tonsillitis, and septic processes also must be considered in differential diagnosis.

Control.—Sayers²⁴ is of the opinion that metal fume fever may be eliminated through the adoption of an adequate medical and engineering program. A study of the industrial exposure responsible for the illness should be requested by the industrial physician. In conducting preplacement or transfer examinations, it should be remembered that the clinical course of chronic respiratory conditions, such as bronchiectasis, asthma, and arrested tuberculosis, and chronic heart disease may be unfavorably influenced by the fever and chills.

Cadmium Poisoning

The great increase in the use of cadmium, not only for coating marine hardware but also for many fittings that were formerly zinc coated, has created a new problem in industrial hygiene. Most cases of industrial cadmium poisoning have resulted from accidents or short exposure to excessive concentrations of cadmium dust or fume. Little is known of chronic effects upon humans. Acute industrial poisoning is characteristically produced by inhalation of the fumes, particularly where cadmium has been heated to give off the oxide in yellowish-brown fumes.

Symptoms.—The clinical picture²⁶ is characterized by irritation of the respiratory mucous membrane which may eventually lead to pulmonary edema, pneumonitis, or bronchopneumonia. The first symptoms are those of metal fume fever, usually dryness of the throat, cough, chills, headache, vomiting, and a sense of constriction of the chest. Later symptoms are predominantly referable to the respiratory system and are characterized by cough, pain in the chest, severe dyspnea, and prostration. A few cases have gastro-intestinal complaints.

Differential Diagnosis.—Poisoning with nitrous fumes and methyl bromide may be ruled out by history. Metal fume fever caused by zinc oxide fumes usually clears up within 24 hours. Therefore, the continuance and aggravation of symptoms such

as occur with irritant gases which produce acute pulmonary congestion make it imperative to consider cadmium. These serious delayed symptoms²⁷ should not be confused with nonoccupational diseases.

Treatment.—Treatment is palliative. Oxygen should be used in moderately and severely affected cases without waiting for signs of pneumonia. Rest is acutely essential as is the withdrawal of the worker from the source of contact.

Manganese Poisoning

Manganese is used principally in the manufacture of alloys, for example, ferromanganese, and to a lesser extent in the manufacture of dry cell batteries, paints, matches, and fireworks, and in leather tanning. In the crude black ore most of the manganese is present in the form of the dioxide.

Symptoms.—Industrial manganese poisoning is a chronic disease characterized by neurologic symptoms and is usually the consequence of inhaling manganese dust or fumes. The important symptoms are muscular stiffness, twitching and incoordination, giving rise to difficulty in walking, and propulsion gait. Speech defects, a mask-like facial expression, drowsiness, weakness, and emotional instability may also be present. In *differential diagnosis*, disseminated sclerosis, paralysis agitans, and progressive lenticular degeneration must be ruled out.

Control.—Flinn, Neal, and Fulton²⁸ advise quarterly medical examination of workers exposed to manganese dust and the immediate transfer to a manganese-free environment of any workers showing signs of early poisoning, until the hazard has been controlled.

Mercury Poisoning (Hatters' Shakes)

The principal ore from which mercury is derived is cinnabar, or mercuric sulfide. Some cinnabar mines also yield native quicksilver. In 1940 there were 159 mercury-producing mines²⁹ in the United States and Alaska, with the greatest production coming from the States of California, Oregon, and Nevada. Besides the mining of mercury, some other potential sources of mercury hazard arise from its use in thermometers, barometers, extraction of gold from its ores, dental alloys, mercury arc lamps and rectifiers, anti-fouling marine paints, agricultural disinfectants, radio equipment, analytical laboratories, explosives, and certain chemical industries. Dublin and Vane³¹ list about 100 occupations in

which mercury may be a hazard. Mercury is being replaced in the fur-hatting industry by less toxic chemicals.³⁰

Industrial mercury poisoning occurs almost exclusively from the inhalation of mercury vapor or dust of the metal and its salts, yet poisoning through the ingestion, cutaneous, and subcutaneous routes may infrequently occur.³¹ Elemental mercury gives off vapor at ordinary room temperatures. Mercury is "a general protoplasmic poison." After it gains entrance to the circulation, it is rapidly taken up by the tissues. The form in which mercury circulates in the body is not definitely known³² though some feel it is as an albuminate such as mercury chloroalbuminate, or oxy-chloro-albuminate.

Symptoms.—The cardinal symptoms of industrial mercurialism are stomatitis, psychic disturbance, and tremors. These symptoms are not present simultaneously in all cases nor in the same degree.³³ Industrial mercury poisoning is typically chronic though cases of severe, rapidly developing mercurialism characterized by colicky pain, diarrhea, painful stomatitis, and excessive salivation may occur occasionally "in such jobs as mining metallic mercury, when the silver runs free, as the miners say, and the mine is hot."³⁴ There is rarely much kidney involvement in the industrial form of the disease. A blue line on the gums resembling that due to lead absorption is seen in a few cases. Tremor and other signs of neurologic origin are more characteristic of an insidious, slow form of poisoning. The tremor is observed mainly in the muscles of the face, hands, and arms; it is intention in type, becoming most apparent while the patient is doing an unusual task. As the tremor grows worse, shaking or convulsive movements are added to the tremor, giving rise to the typical picture of hatters' shakes. Mercurial erethism or psychic irritability is intimately related to the tremor and may include or lead to loss of memory, insomnia, and depression. Hyperactive knee jerks and scanning speech are frequently present in advanced cases.³⁵

Mercury fulminate rarely produces symptoms of systemic mercurial poisoning; the cases are usually characterized by a *dermatosis* associated with conjunctivitis and inflammation of mucous membranes of the nose and throat.³⁶

Radium Poisoning

Because luminous dials are needed on instruments in night operations of the armed forces, there has been a great increase

in the use of luminous paints. These paints are usually a mixture of phosphorescent zinc sulfide and radium, mesothorium, or other similar radioactive substances.³⁷ Another source of industrial disease is in the mining and refining of radioactive ores.

The *harmful effects* of radium are caused by *ingestion, inhalation, injection* of radioactive substances, or *whole body exposure* to gamma radiation. It is necessary to understand the genetic connection of all members of the radium family because these elements taken all together produce the effects ascribed to radium.

The damage produced by various types of radiation is determined by their nature and properties,³⁸ thus, (1) alpha rays have enormous energy but low power of penetration and to produce injury they must come in intimate contact with the tissues they injure, (2) beta rays penetrate several feet of air, and (3) the gamma rays can penetrate several centimeters of lead.

All radium³⁹ disintegrates at a slow but definite rate into radon, a radioactive gas. In the body of a victim of radium poisoning, some of the radon is exhaled and that which is not exhaled disintegrates *in situ* into a series of solid radioactive substances, eventually becoming lead. Like lead, radium has been shown to be stored largely in the bones. Radium induces bone injury as well as damage to the hematopoietic system. It is eliminated mainly in the feces. Although only about 10 per cent of the amount of radium taken into the body becomes fixed in the tissues, this fraction exposes the tissues to the destructive action of the radiations from the various members of the radium family. Among dial painters tissue damage is almost entirely due to *alpha* radiation, as studies of bone deposits show that about 92 per cent of the radiation is *alpha* and only 8 per cent *beta* and *gamma*.

The common industrial form of radium poisoning,⁴⁰ such as occurred in radium dial painting, should not be confused with the deleterious effects of external application. The industrial form is an insidious chronic disease. The patient for many years after exposure remains in good health. According to Martland⁴⁰ patients having 120 to 180 micrograms of radium in their bodies will usually develop extensive radiation osteitis within 1 to 5 years. A complicating bacterial, dental infection will not uncommonly lead to extensive necrosis of the jaw bones. Macrocytic, hyperchromic anemia may develop at first, followed by aplastic anemia. Patients retaining 2 to 20 micrograms of radium often escape jaw necrosis, but tend to develop crippling bone lesions

such as coxa vara, osteoporosis of the flat bones of the skull, deformities of the spine, spinal fractures, and osteogenic sarcomata.

Even such small amounts as 1 to 2 micrograms may produce definite bone change.⁴¹ When the amount of radium a worker has deposited in his body exceeds 0.1 microgram, as revealed by the expired air test, immediate change of his occupation and treatment by decalcification therapy or other mode of therapy which may have been developed is recommended.³⁷ Curtiss³⁸ states that if a sample of exhaled air is found to contain more than 10–12 curie of radon per liter, it indicates that at least 0.1 microgram of fixed radium exists in the body.

Treatment is largely symptomatic. The decalcifying therapy of a low calcium diet and ammonium chloride, as used by Aub and his coworkers, has been shown to increase the excretion of radium, but it does not greatly reduce the total deposition of radium in the body. This method of therapy is possibly of value early in the disease when the radium is contained in the trabeculae rather than in the cortex of the bone.

As regards *medical control*, thorough medical and dental examinations should be performed before employment. The complete blood count made at the time of preemployment examination serves as a reference index for subsequent blood counts. Periodic occupational examinations including hematologic studies should be made at intervals of about one month and particular attention given to the trend of successive blood counts. Many authorities prefer to have the expired air radon test, which is made at intervals of six months or one year, because a dangerous radium accumulation may be detected in this way before it has had time to induce changes in the blood picture. Leucopenia, relative lymphocytosis, or beginning anemia calls for careful investigation and possibly change of occupation for the worker concerned.

Silicosis (Occupational Pulmonary Fibrosis, Pneumoconiosis)

Definition.—Pneumoconiosis is a broad generic term applied to all dust affections of the lungs. In a more restricted sense, it means pulmonary fibrosis induced by inhaled *mineral* dust. The committee on Pneumoconiosis of the American Public Health Association⁴² defines silicosis as “a disease due to breathing air containing silica (SiO_2), characterized anatomically by generalized fibrotic changes and the development of miliary nodulation in both lungs, and clinically by shortness of breath, decreased chest

expansion, lessened capacity for work, absence of fever, increased susceptibility to tuberculosis (some or all of which symptoms may be present), and by characteristic X-ray findings.”

Classification.—On the basis of the structural changes induced in the lung and the type of dust, the pneumoconioses or pulmonary fibroses may be classified as follows (compare reference 43) :

1. *Simple benign pneumoconiosis*, which is virtually a deposition of dust in the pulmonary tissues usually accompanied by pigmentation, and includes, for example, anthracosis induced by coal dust and siderosis induced by iron. It does not incapacitate and roentgenologically shows as a maximum change only an exaggeration of linear pulmonic markings and is of clinical interest only by way of differential diagnosis. Such cases should never be diagnosed as silicosis.
2. *Silicosis*, which is a pathologic pulmonary reaction due to free silica ; for example, sandblasters' silicosis. This type of pneumoconiosis results in a classical nodular fibrosis of both lungs, demonstrable both in the X-ray and at post mortem. Massive fibrosis, varying degrees of pigmentation, atelectasis, emphysema, fibrous pleurisy, bronchitis, cavitation, and pneumothorax are among the concomitant pathologic changes.⁴⁴
3. *Mixed forms*, that is, silicosis resulting from the inhalation of mixtures of varying amounts of free silica and more inert pneumoconiogenic dust constituents, for example, anthracosilicosis and siderosilicosis. Most cases of silicosis undoubtedly come under this classification.
4. *Asbestosis*, a characteristic diffuse, interstitial fibrosis of the lungs induced by fibrous minerals which, according to animal experimentation, is due to the mechanical action of the asbestos, producing a ground-glass appearance on the X-ray. It may cause disability and a few fatal cases have been recorded.

Etiology.—Silicosis is incurable and large numbers of workmen are potentially exposed to conditions favoring the development of the disease. The majority of cases of this chronic pulmonary disease occur among workers engaged in mining,⁴⁵ quarrying, ceramics industry, tunnel construction, sandblasting, and foundry work.

Inhalation of siliceous dust almost invariably results in sili-

cosis if a certain set of conditions has prevailed during the working experience of the worker. Among these silicosis-producing conditions are:

1. The dust must be of respirable size (usually 0.5 to 3 microns).
2. The dust must be present in the atmosphere at the breathing level of the worker in concentrations exceeding 5 million particles per cubic foot.
3. The dust must be inhaled for a number of years.
4. The dust must contain silica in a free state, such as quartz.

Generally speaking, the inhalation of high concentrations of respirable high quartz dust produces disabling disease in a shorter period of time than the inhalation of low concentrations of dust or dust of low quartz content.

Legislation.—The following States, which include the 11 States subscribing to blanket coverage, either list silicosis in schedule occupational disease laws, or make certain provisions for the disease:⁴⁶ Arkansas, California, Connecticut, Delaware, Idaho, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Michigan, Missouri, Montana, New York, North Carolina, North Dakota, Ohio, Pennsylvania, Utah, Washington, West Virginia, and Wisconsin.

Incidence.—It has been estimated on the basis of the 1930 census that between 500,000 and 1,000,000 workers are exposed to silica dust.⁴⁵ Clinical investigations, including X-ray studies, in various dusty trades have shown that from 8 to 25 per cent of the employed workers have potentially disabling pneumoconiosis; thus a high proportion of workers in these dusty trades would appear to have escaped the disease. This resistance of some workers, however, is more apparent than real⁴⁷ if consideration is given to the relatively long latent period required before the disease can be demonstrated clinically or even by X-ray study.

A great majority of the cases develop after at least 7 years of exposure, although a few cases have developed in as short a period of time as 1½ years. At the other extreme, with exposures to low concentrations of free silica, more than 30 years may have to elapse before the disease develops to a stage when it can be diagnosed.⁴⁵

Symptoms and Signs.—The worker showing X-ray evidence of an early to a moderate amount of simple silicotic involvement has few symptoms. Moreover, symptoms and physical signs are of little help in determining whether the patient has a silicosis, a modified silicosis (for example, anthracosilicosis), or asbestosis.

Symptoms and signs do, however, assist in the determination of disability. Among the symptoms and signs of importance are shortness of breath, particularly upon exercise; cough, usually dry; chest pain, varying from a feeling of tightness in the chest to the sharp, excruciating pain typical of pleurisy; hemoptysis; general complaints such as digestive disturbances, insomnia, and dizziness; decrease in chest expansion; prolonged expiration, especially in association with emphysema; altered breath sounds; rales; and the presence of areas of increased density in the lungs. Infection may complicate the picture at any time and is usually manifested by pleural pain, fever, night sweats, weight loss, aggravation of dyspnea, anorexia, weakness, and a cough producing large amounts of blood-tinged sputum.

Diagnosis.—In establishing a diagnosis of one of the pneumoconioses, all of the following three factors should be considered.*

1. An occupational history which reveals definite prolonged exposure to siliceous dust or asbestos dust.
2. Symptoms and physical signs which furnish valuable information in (a) gauging the extent to which pneumoconiosis has progressed, (b) showing the degree of disability, and (c) excluding other diseases.
3. X-ray findings, which, if classified on the basis of the system recommended by the U. S. Public Health Service, show bilateral ground-glass, nodular, or a more advanced type of lung-field marking.

So long as the chest roentgenograms show predominantly linear pulmonic markings, silicosis or modified silicosis need not be given serious consideration. It is when the shadows in the lung field assume a ground-glass, granular or nodular appearance that they become specific and assume more diagnostic characteristics. Using Irvine and Steuart's analogy,⁴⁸ the usual linear pulmonic markings are likened to the branches of a tree and the granular, stippled, or nodular lung-field markings simulate the leaves. Complete foliation then means silicosis. Viewed stereoscopically, the films at this stage will show fine nodulation. Some writers describe a related change in the lung-field appearance as reticulation.⁴⁹ Although not definitely determined, this type of lung-field marking may result from the inhalation of mixed dusts. Later stages will show massive areas of fibrosis, and if infection is present the X-ray shadows tend to be asymmetrical.

Asbestosis is exceptional from the standpoint that the pul-

* In the field of forensic medicine it has been frequently demonstrated that autopsy studies will yield essential information.

monary fibrosis is caused by dust containing little if any free silica. The asbestotic patient will usually show clinical symptoms and signs which are out of proportion to the apparently small amount of pulmonary involvement shown by the chest roentgenogram. Large massive shadows are very rarely seen in the chest roentgenogram except in the presence of a complicating infection. On the contrary, the diffuse interstitial fibrosis is manifested by a ground-glass appearance, frequently with fine pinpoint stippling of the middle and lower lung fields. It progresses to terminal diffuse fibrosis usually without nodular predominance in about twenty years.⁵⁰ A shaggy appearing cardiac silhouette due to involvement of superimposed lung structures and pleuropericarditis is not infrequent. Asbestosis bodies may be demonstrated in the sputum or the lung tissue.

Medical Control Measures.—All applicants for employment in dusty trades should be examined by X-ray. Periodic medical examinations at intervals of one year to possibly three years, including X-ray study of the chest, should be made of all workers in dusty trades in order to detect evidence of active pulmonary tuberculosis and early silicotic changes. The length of the interval between examinations depends mainly on the degree of hazard and the prevalence of endemic tuberculosis.

Clinical study of patients suspected of having pulmonary tuberculosis should be made to determine the dynamic status of such complication. No worker should be rejected on preemployment examination or removed from work, which he is accustomed to perform, merely because of a diagnosis of simple silicosis, but rather the atmospheric dust in which he works should be brought within safe limits. The worker whose first roentgenogram shows healed primary tuberculosis should not be denied employment in a dusty trade on this account alone. If the worker has minimal, arrested, or healed reinfection tuberculosis, he should be allowed to continue his work but should be observed with the same precautions as a man with simple silicosis. Close medical supervision is recommended for all silicotic workers in order to control or prevent serious complications of the common respiratory infections.

Benzene (Benzol) Poisoning

Benzene (benzol) is an excellent solvent for gums, resins, fats, and oils, and as such has found many industrial applications. It is used in the manufacture of rubber, rubber goods,

linoleum, quick drying paints, lacquers, stains, paint removers, and plastics. Benzene should not be confused with the less toxic petroleum product, *benzine*, which is a mixture mainly of aliphatic hydrocarbons.

The most characteristic *pathologic changes*⁵¹ in cases of benzene poisoning are seen in the bone marrow which may show gradations of change from hyperplasia to hypoplasia and occasionally complete aplasia of the myeloic cells. Other parts of the hematopoietic system may also be involved. Depending on the degree of exposure, secondary degenerative changes are observed in the liver, kidneys, and heart.

Symptoms.—Acute benzene poisoning follows the inhalation of benzene vapors in high concentration and provokes narcotic symptoms such as inebriation, fatigue, sleepiness, vertigo, tinnitus, nausea, vomiting, and headache. If exposure is prolonged, muscular twitching, convulsions, paralysis, and loss of consciousness may result. With very large doses, unconsciousness, convulsions, and death due to respiratory paralysis may occur rapidly.

The more typical industrial benzene poisoning is *chronic*, and is a complex hematologic syndrome characterized by anemia, purpura, and granulocytopenia. The associated subjective complaints are fatigue, somnolence, headache, vertigo, general debility, and gastro-intestinal disturbances. The *blood picture* may be variable. A drop in white cell count (especially involving polynuclears) below 5000 to 5500 is usually considered a sign of incipient poisoning. Anemia and corresponding change in hemoglobin usually occur after toxic effects on white blood cells become manifest. Leucocytosis, eosinophilia, and polycythemia are occasionally observed.

The *urine* may contain albumin, casts, and bile pigments.

In the proper placement of personnel, juvenile and pregnant workers and those suffering from chlorosis, tuberculosis, organic heart disease, hemorrhagic diathesis, and anemia should ordinarily be excluded from positions entailing a hazardous exposure.

Medical Control.—Occupational examinations of exposed employees, including blood studies, should be made at intervals of approximately one month, gauging the frequency to severity of exposure. The ratio of inorganic to total sulfates should be determined, a reduction of which will indicate the existence of exposure to benzene.⁵² In case, upon repeated examination, the percentage of organic sulfate is 30 per cent or more, the concen-

tration of benzene in the air of such operations should be determined and reduced by proper engineering methods.⁵¹

Carbon Monoxide Poisoning

Carbon monoxide poisoning may occur in a great number of industrial operations.⁵³ The gas, CO, is formed by the incomplete combustion of organic materials. Its action on the body is related to its affinity for hemoglobin which is 300 times that of oxygen. When inhaled it forms carbon monoxide-hemoglobin, and thus causes anoxemia in proportion to the amount of carbon monoxide-hemoglobin in the circulation. Carbon monoxide poisoning is usually acute. Whether or not chronic carbon monoxide poisoning exists as an entity is controversial and seems largely dependent on the interpretation of the word "chronic." It appears that continued exposure to moderately toxic concentrations will result in disturbances of the circulatory and nervous system.

Symptoms.—Blood saturation up to 15 per cent HbCO rarely produces symptoms, but when the blood saturation is from 15 to 20 per cent, tightness across the forehead, possibly slight headache, and dilation of cutaneous blood vessels are observed. When the blood saturation is 30 to 40 per cent, the common symptoms are severe headache, weakness, dizziness, dimness of vision, nausea and vomiting, and collapse. Coma with intermittent convulsions, depressed heart action, and possibly death are symptoms occurring with HbCO concentrations of 60 to 70 per cent. With exercise, latent symptoms often become manifest and existing symptoms are aggravated. On exposure to high concentrations, the victim may notice few, if any, symptoms, yet he may without warning become unconscious and die without regaining consciousness.

Treatment.—The treatment of carbon monoxide poisoning should always be carried out by a qualified physician, although first aid must be given pending his arrival. In summarizing experience with the treatment of carbon monoxide poisoning, the following procedure, outlined by Sayers,^{53, 54} is recommended:

1. The victim should be removed to fresh air as soon as possible.
2. If breathing has stopped, is weak and intermittent, or present in but occasional gasps, artificial respiration by the Schäfer method should be given persistently until normal breathing is resumed or until after the heart has stopped.
3. Pure oxygen or a mixture of 5 per cent carbon dioxide and 95 per cent oxygen should be administered using an inhaler, beginning as soon as possible and continuing for at least 20 minutes in mild

cases and as long as 3 hours, if necessary, in severe cases if the patient does not regain consciousness. The administration of oxygen or of the mixture of carbon dioxide and oxygen when given immediately will greatly lessen the number and severity of the symptoms from carbon monoxide poisoning and will decrease the possibility of serious after-effects.

4. Circulation should be aided by rubbing the extremities of the patient and keeping the body warm with blankets, hot-water bottles, hot bricks, or other devices, care being taken that these objects have been wrapped or do not come in contact with the body and cause burns.
5. The patient should be kept at rest, lying down to avoid any strain on the heart. Later he should be treated as a convalescent and should be given plenty of time to rest and recuperate. Exercise was at one time recommended; however, the procedure is hazardous, as the patient quite often loses consciousness, and in some cases death occurs.

CONCLUSION

Occupational disease legislation has been discussed and certain occupational diseases have been briefly described. It is apparent that in the practice of industrial medicine, many questions of compensation arise. It is for this reason that the industrial physician should have a thorough knowledge of the occupational disease laws applying to the workers for whom he is responsible. Many of the questions that arise in connection with such compensation are medical in nature and demand medical solutions.

As more and more handicapped workers must be taken into industry, deficiencies in present compensation laws become apparent. Legislation amending certain of the laws is indicated in many instances, and, in others, enlightened administration of the law is needed, particularly as related to waivers and second-injury provisions.

In his daily practice, the industrial physician should secure accurate and complete occupational and other histories, perform thorough physical examinations, and, in the instance of a claim, submit his impartial report promptly to the administrator of compensation.

The physician has a major role to play, not only in the treatment but also in the control and prevention of disease in industry.

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CHAPTER 10

OCCUPATIONAL DERMATOSES

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THIS chapter is restricted to dermatoses affecting only those engaged in manufacturing materials for actual combat. Included are airplanes, tanks and other armored vehicles, motors, firearms, explosives, and vesicant and incendiary agents of chemical warfare.

DIAGNOSIS

There is no one factor upon which a diagnosis of industrial dermatitis can be made. In most instances the appearance of the lesions gives no clue to the irritant. Especially is this so in the acute and chronic eczematoid types of occupational dermatoses. All of the following factors must be considered and each one forms only a link in the chain of evidence on which a diagnosis of industrial dermatitis should be made.

History of the Dermatitis

The history of the dermatitis is most important. For the dermatitis to be considered as of possible occupational origin, it must be brought out that such a dermatitis was not present before the patient entered on the occupation. It must also be shown that the dermatitis developed during the period of industrial exposure, or after a lapse of a reasonable incubation period since the cessation of exposure. If the history shows that other workers similarly employed are similarly affected, or that new workers at the process are usually similarly affected, then the possibility of a diagnosis of industrial dermatitis is strengthened. If the history should disclose that the patient has had similar attacks of dermatitis previous to the present exposure, then the possibility of the present attack being due to his occupation is weakened; the possibility, however, still exists since in his previous employment he may have met with the same irritant or conditions which are now causing his dermatitis. Knowledge by the physician of the working processes in which the patient is engaged and the substances with which he comes in contact is

important, because this enables him to know whether the worker is exposed to known irritants or to conditions which tend to cause dermatitis. For instance, if a worker appears with deep sago-like vesicles on his palms, and states that he is in the mixing department of a TNT production line, then we know that he is exposed to irritant compounds (TNT and ammonium nitrate) and is more likely to develop an occupational dermatitis than is a worker who handles only the fully loaded shells. If the history shows that the dermatitis develops whenever the worker is at work, gets well or improves when he is away from work and recurs when he returns to work, then the history itself establishes a definite cause and relation factor between the occupation and the dermatitis.

Site of Eruption

The site of the eruption is also important. In examining patients, they should be completely divested of clothing. This may in many cases reveal areas of dermatitis on portions of the body not complained of by the patient and may give the clue to a proper diagnosis. Occupational dermatitis usually begins on the *exposed parts*—the hands, the fingers and the forearms, if the offending material is a solid or a liquid; and also on the face and neck, if it is a vapor. The covered parts of the body may also be affected, if fumes or vapors penetrate the clothing, or if the clothing is not frequently washed and becomes saturated with irritant chemicals. Thus, dermatitis may occur on the body of the worker handling irritant dusts which penetrate the clothing, such as finely powdered rubber compounds; or dermatitis may occur on the covered parts of the body when the clothing becomes saturated with petroleum oils and waxes, especially if the worker does not take daily cleansing baths and if he does not change his work clothes daily.

Occupational dermatitis is also often found at *points of friction* on the body. The wrist where the ends of the gloves or the sleeves rub; the belt line where the belt or the top of the trousers causes friction; the ankle at the shoe tops; and the neck at the collar line, are all sites where friction aids the action of industrial irritants. Sometimes a dermatitis of undoubted occupational origin may become generalized. This occurs when the irritant is one to which the worker has developed a high degree of sensitivity. Many substances are known to be sensitizers. Nitro, nitroso and the chloro compounds are notorious sensitizers. In such in-

stances a primarily localized dermatitis or burn may also sensitize the patient and a few days later a generalized dermatitis may develop.

Characteristic Appearance of Lesions

An industrial dermatitis of the acute eczematoid type begins as an erythema followed by papules and vesicles and, when the vesicles break, by oozing and crusting, no matter what irritant is the cause.

There are, however, a few classes of industrial irritants which produce more or less characteristic lesions on certain portions of the body. The chlorinated naphthalenes and diphenyls produce acne-like lesions on the face and on the parts of the body which come in contact with the work clothes if the work clothes are not frequently washed and changed. Certain tar compounds also cause acne-like lesions on the exposed parts. Oils cause folliculitis and boils, especially on the hairy portions of the body. Paraffin, grease and tar cause keratoses to develop on the hands and forearms, and these keratoses occasionally become malignant. Certain hydrosopic chemicals, such as sugar, salt and lime which remove the water from the skin, and solvents, such as the petroleum distillates which remove the fat from the skin, may over a long period of time cause dry, fissured eczemas.

Differential Diagnosis

Occupational dermatitis must be differentiated from such diseases as seborrhoeic dermatitis, fungus infections, lichen planus, impetigo contagiosa, pityriasis rosea, erythema multiforme, drug eruptions, neurodermatitis, and dermatitis due to contact with irritants met with outside of the place of occupation. The industrial physician or the general practitioner may at times be in doubt about the diagnosis of these conditions in a worker exposed to an occupational skin hazard especially if he does not strip the patient and examine the entire surface of the skin, but to the dermatologist the characteristic location or appearance of seborrhoeic dermatitis, lichen planus, impetigo contagiosa and neurodermatitis, and the generalized eruptions of pityriasis rosea, erythema multiforme and drugs offer no great problem in differential diagnosis from occupational dermatitis. It is true that the presence of these conditions does not rule out the fact that an industrial dermatitis may also be present. In fact, the pres-

ence of certain of these skin diseases often predisposes a worker to an industrial dermatitis. The greatest difficulty in differential diagnosis is presented by dermatitis due to contact with substances met with outside of the place of occupation. In these cases the lesions are similar in appearance and site, and only the most careful consideration of all the facts can lead to a correct etiology. It is here that the patch test is of greatest value.

Fungous infections offer a problem in differential diagnosis from industrial dermatitis. A large percentage of workers is affected with mycotic infections in some form or other. Epidermophytosis of the feet and hands, tinea cruris and tinea versicolor are common skin diseases. Allergic reactions in the form of dermatoses on distant parts of the body resulting from these fungous infections are recognized by allergists and dermatologists. These allergic reactions or phytids may be confused with industrial dermatitis. If the phytids or the mycotic infections appear on portions of the body not exposed to industrial irritants, they are not so likely to cause doubts in diagnosis, but they often appear on the hands and here they may cause trouble in diagnosis. The various tests with fungus extracts, such as trichophytin, are of little value in making a differential diagnosis because nearly every one has or has had a fungous infection, and thus positive reactions are the rule. They are of more value when the tests are negative, because then they tend to show that the present eruption is not of fungous origin, although even here it is not absolute proof, because among other reasons the causative fungus may not be the one from which the testing extract is made. Then again, the fact that a worker has a fungous infection does not preclude the fact that he may also have an industrial dermatitis. In fact, it is held by some dermatologists that the presence of a fungous infection predisposes to hypersensitivity to other external irritants. Patch testing may offer some help but here again the industrial exposure, the history of the eruption, and the site of the lesions and their morphology must all be carefully considered before a diagnosis is made.

Chronic eczemas more or less generalized and of long standing offer difficult problems in etiology, especially when they are complicated by secondary infections. Patch tests are of little value in most of these cases because polysensitivity is usually present. It is impossible to determine whether the dermatitis and polysensitivity were caused by industrial exposure or whether the sensitivity was present before the industrial exposure or

whether the dermatitis and sensitivity were caused by exposure to substances encountered outside of the workroom.

From these facts it can be seen that there is no one characteristic symptom on which a diagnosis of an industrial dermatitis can be made. The worker's occupation, the history of his skin eruption, its site and morphology, and evaluation of the patch tests must all be taken into consideration by a dermatologist familiar with the substances and the processes connected with the worker's occupation before he can hope to make a diagnosis as to the etiology of a doubtful case of dermatitis in a worker exposed to an occupational skin hazard.

The Patch Test

The patch test is based on the theory that if a dermatitis is caused by hypersensitivity to a certain substance, the substance, when applied to an area of unaffected skin of the susceptible individual and left on for a period of time, will cause an inflammation at the spot where it touches the skin. In doing patch tests, it is important to know what concentrations of certain chemicals can come in contact with the normal skin for a stated period of time without causing an inflammation or reaction.¹ It is also important that no primary irritants, such as strong acids or alkalis are used in the patch test, because obviously they will burn any skin. The portion of the body on which a patch test is to be performed is also of importance because it has been found that the different portions may vary in sensitivity to certain chemicals. For instance, the tough horny skin on the hand is less susceptible to irritants than the more tender skin on the inner surface of the forearm. Moreover, it has been found that the area of the skin surrounding the affection is more sensitive than other portions of the skin. For this reason, patch tests performed on uninfamed skin adjacent to the eruption are more likely to give positive reactions than when performed on more distant areas. It may even be necessary to wait until the eruption heals so that patch tests may be performed on the portion of the skin which was affected.

If the worker is handling known irritants and his fellow workers are also affected, the cause is obvious and the patch test is unnecessary, but if he is the only one of the group who is affected, then he should be patched with materials with which he comes in contact in the course of his occupation. If he is patched with only one substance, then a control patch should be

placed on him. If he is patched with more than one substance, then any negative reaction from one of these substances serves as a control. It is also desirable to use as a control one of the workers on the same job who has no dermatitis.

Technique.—The technique of the patch test requires the placing on the normal skin of a small portion of the suspected substance moistened with water, if a solid, or if in solution, a $\frac{1}{4}$ inch square piece of inert material, such as surgical gauze four plies thick, saturated with the substance. (Proper dilutions and solvents will be described for each substance under its specific discussion since there is considerable variation.)

Tests are usually placed on the anterior surfaces of the arms or on the back. They are covered with a one inch square of non-irritating material such as wax paper, mica, or nonwaterproof cellophane, and attached on the skin by a larger piece of adhesive plaster, approximately 2 inches square.

Interpretation.—To arrive at a correct etiologic diagnosis the results of patch tests must be correlated with the worker's particular occupation, the history of the dermatitis, and the site and morphology of the lesion. Patch tests are only a link in the chain of evidence on which a diagnosis of industrial dermatitis is made. A positive reaction shows only that the portion of the skin on which the patch was applied was at that time sensitive to the substance with which it was patched. In order to state that this substance was the cause of the occupational dermatitis, we must be sure that the patient was exposed to the substance in the course of his work and presuppose that the patient's skin was also sensitive at the time of industrial exposure.

When *negative results* are obtained from patch tests with the materials met with in the course of the patient's occupation, we must not hastily conclude that the dermatitis is not of industrial origin, because the skin area over which the patch was placed may not be hypersensitive, while the area covered by the eruption may be hypersensitive. Or, if the eruption has disappeared, the patient may no longer be sensitive when the patch test is performed but may have been sensitive at the time he had the eruption and when he was industrially exposed. Or, a negative patch test reaction may be due to the fact that the patch test never accurately reproduces actual working conditions, such as friction, maceration, heat, cold, and sunlight, which may be additional factors adding to the irritating effect of the substance to which the patient is exposed. Or, it may be that the concen-

tration of the chemicals applied as a patch test may not be as great as they actually were during industrial exposure. Or, finally, the actual industrial irritant may not have been discovered and applied as a patch test. When negative reactions are obtained from patch tests with substances encountered in the work room, and the dermatitis which the worker has resembles a contact dermatitis, an effort must be made to perform patch tests with materials met with in the patient's home which may be causes of dermatitis; such materials may be certain plants, or paints or possibly new furniture. Tests of this kind will in some cases show that the patient is sensitive to materials met with outside of industry and not sensitive to the materials which he meets in his place of employment.

Precautions.—The technique of performing patch tests is important in obtaining and evaluating results. When patch testing is done with substances that are primary irritants, such dilutions must be used in the tests as are known not to irritate the normal skin.² The insulating material inserted between the chemical and the adhesive plaster should be a nonirritant substance, such as unvarnished cellulose or, better still, a thin sheet of mica. The resin on waterproof cellophane itself may be an irritant as may be some of the compounds in dental rubber. The adhesive plaster used to hold the patch in place often itself causes an erythema of the skin.³

At the time the patches are removed there may be no reaction present, but some time later—a few hours to a few days—a delayed reaction may develop at the site of the patch. This also denotes sensitivity. Patch tests properly performed and evaluated can be of great help in the diagnosis of industrial dermatitis, but if improperly performed and evaluated, they may lead to confusing, erroneous and unjust conclusions.

PREVENTION

Prevention is the most important factor in the elimination of industrial dermatitis. The basic principle is separation of the irritant from the worker. This may be done by mechanical means such as the use of hoods, suction apparatus and other devices to prevent irritating substances from reaching the worker or by personal protection as protective clothing and protective ointments. Only individual protection will be considered in this chapter.

Personal Cleanliness

It is highly necessary that workers have adequate washing facilities. This implies enough wash stands or showers and a sufficient quantity of hot water as well as cold. There should also be adequate time to enable thorough cleansing, change of clothes and dressing between the end of work and the time when transportation facilities are available. Many plants give too little time between the end of work and the bus home.

Protective Clothing

Fabrics impermeable to chemicals are preferred for protective clothing because materials permeable to liquids or gases offer protection only if frequently changed and cleaned. Otherwise they tend to become saturated and may actually act as poultices for the very irritants against which they are being used. *Rubber* and *oil cloth* are excellent protectives but have many disadvantages to which workers object. Rubber is heavy and increases the amount of perspiration by preventing its evaporation. Rubber is attacked by many of the industrial solvents such as petroleum solvents, carbon bisulfide and the chlorinated hydrocarbons. Furthermore, rubber may cause dermatitis itself. Oil cloth is heavy rather than pliable, inflammable, and is attacked by even more substances than is rubber.

Synthetic resin films which are resistant to the action of organic solvents and which are more or less transparent and light in weight may be better adapted for protective clothing than rubber. Among these are Pliofilm, Koroseal, and Vinylite (trade names). The polyvinyl alcohols, which are insoluble in almost all the solvents except water, have been made into gloves. Ordinary cellophane can be made flameproof and if of proper thickness protects against most solvents, acids, and alkalis, but is softened by water. During the present shortage of critical materials it is often necessary to improvise protective clothing or guards from whatever material is obtainable.

Some basic principles for protective clothing follow. Unless clothing is comfortable, workers will object to it. It must be sufficiently pliable to permit free movement, perforated in some portions to permit the evaporation of perspiration, and neither so delicate that it will tear on the slightest force nor so strong that it will drag a worker's arm into a machine if caught in a moving part.

Gloves should be made of washable material and should fit fairly snugly; they should not be cumbersome and should extend a sufficient distance beyond the wrist so that they fit under the sleeves. To prevent irritation of the hands, seams of gloves should not be rough.

Sleeves should reach from the wrist to the armpit. They should be fastened at both the wrist and at the upper end and should reach sufficiently high on the arm. They should fit snugly over the forearm to prevent their being caught in machinery, and should be sufficiently roomy to allow for freedom of the elbow without sliding up and down the arm. They should have vents near the top to permit the evaporation of perspiration. They should also be fireproofed where fire hazard exists.

Aprons should be full and cover the body from well below the knees to the neck. They should be fastened around the neck and the waist. Aprons can be split in front so that each leg may be separately protected by fastening behind.

Hoods should fit over the head and come down to the shoulders to protect the collar line. In occupations where it is necessary to protect the entire face and neck, the hood can be entirely closed except for an opening at the mouth which should be so constructed that a removable air filter can be fitted in. At the top or back of such a hood there should be a flap valve to allow the escape of expired air.

Coveralls should fit snugly at the neck and may have zipper fronts.

Protective Ointments

Protective ointments are the least efficient of preventive measures. In certain procedures the chemicals of the protective ointment may contaminate and interfere with the working qualities of the substance against which the ointment is used as a protective. But in many instances ointments are the only available means of protection. For instance, the face cannot always be covered by protective clothing; and certain types of work demand skillful manipulation which requires the use of bare hands.

Protective ointments have some advantages. The workers invariably remove them with soap and water after work which in turn removes whatever irritants are on the skin, thus adding considerably to the protection supposedly given by the ointment. Moreover, workers like to use protective ointments because of the sense of security derived from their action.

Protective ointments should be nonirritating and nonsensitizing. They should offer actual protection from the irritant. They should be of such consistency that they can be applied easily. They should be easily removable from the skin after work, and yet adhere sufficiently to the skin while the worker is exposed to the irritant.

The Six Classes of Protective Applications.—1. *A simple vanishing cream* which when rubbed into the skin fills the pores with soap which facilitates the removal of soil when washing after work.

Type formula:

Stearic acid	20
Sodium carbonate	2
Glycerin	6
Water	78

Melt stearic acid; dissolve sodium carbonate in water and heat to same temperature as stearic acid. Pour hot alkali solution slowly into hot stearic acid, stirring the mixture while pouring and continue until cold.

2. *The "Invisible Glove."*—*An ointment which leaves a film of water soluble or water insoluble resin or wax on the skin and thus prevents the irritant from touching the skin.* This is a good protective against dermatitis of the face from the edges of gas masks and respirators.

Type formula of water soluble invisible glove:

Acacia	5
Tragacanth	5
Borax	2
Water	88

Dissolve borax in hot water. Powder and mix acacia and tragacanth and dissolve in solution.

The water soluble films give some protection against solvents such as petroleum distillates, the solvent chlorinated hydrocarbons, and water insoluble allergens such as trinitrotoluene and tetryl. They are not too efficient because they are easily removed by water and tend to flake off as perspiration accumulates beneath. To counteract this, fats or oils are sometimes added.

Water insoluble resins and waxes are used to repel water soluble irritants.

Type formula:

Gum benzoin	5
Beeswax	2
Anhydrous lanolin	5
Ethyl alcohol	88
Duponol	2

Melt and mix lanolin and beeswax and allow to cool. Dissolve gum benzoin in alcohol, add wetting agent and then dissolve lanolin and beeswax mixture in the solution.

Shellac and nitrocellulose are the most frequently used resins in this form of protective; alcohol, ether and acetone are the usual solvents. Since the resins require a volatile solvent for their application, a special cleanser must be used for their removal unless a wetting agent is incorporated into the formula. When such protective films are used, it is advisable to apply lanolin-cold cream emollient after removal.

3. Protective Ointments Which Cover the Skin and Fill the Pores with a Harmless Fat to Repel Water Soluble Irritants and Prevent the Entrance of Harmful Petroleum Oils, Greases, and Coal-Tar Derivatives.

Type formula:

Anhydrous lanolin	70
Castor oil	30
Perfume q.s.	

Melt lanolin and mix in the castor oil. Perfume when cool.

This class is recommended against cutting oils, greases, and solvents.

4. Protective Ointments Which Contain a Nonirritant Chemical Intended to Detoxify the Industrial Irritant.

Type formula against acids:

Magnesium carbonate	5
Talc	5
Soap	30
Lanolin	30
Castor oil	30
Duponol	2
Perfume q.s.	

Mix soap, lanolin and castor oil. Incorporate magnesium carbonate and Duponol.

The detoxifying chemical used in the cream depends on the specific irritant to be neutralized. Thus a cream to protect against alkalis may contain boric or benzoic acid; one against acids may contain soap and magnesium hydroxide or carbonate; a protective cream against such substances as poison ivy and the vesicant

war gases which are detoxified by oxidation may contain a non-irritant oxidizer such as the various per salts or one that gives off chlorine such as dichloramine T.

5. *Protective Ointments Which Cause Inert Powders to Adhere to the Skin Forming a Protective Covering Against Skin Irritants.*

Type formula against explosives:

Zinc oxide	10
Talc	10
Iron oxide	1
Irish moss	8
Water	10
Alcohol	15
Vanishing cream	46

Dissolve Irish moss in water. Mix with powders and incorporate into vanishing cream.

The powders may be calamine, zinc oxide, iron oxide, kieselguhr, bentonite, etc. The adhesive or binder may be any of the resins used in the invisible glove type of cream. These ointments are of value in protecting against allergenic substances such as the military explosives, and against physical agents which may pierce the skin such as sharp pieces of glass or slivers of steel.

6. *Protective Application against the Photosensitizing Action of the Heavy Coal-Tar Distillates, Distillation Residues, and Excessive Sunlight.*

Type formula:

Lanolin	58
Castor oil	30
Titanium dioxide	5
Methyl salicylate	5
Duponol	2
Perfume q.s.	

Mix lanolin with castor oil. Incorporate titanium dioxide, methyl salicylate, and Duponol.

These contain materials to screen out ultra-violet light such as methyl salicylate, aesculin, cycloform, esuletin, methyl benzoate, benzyl salicylate, quinine oleate, methyl anthranilate, tannic acid, and tannates.

Most of the protective creams, emulsions, and lotions on the market are combinations of these six types of creams. The physician may have to shop around to find those which are best suited to his particular industrial procedure. The workers may already have found the best preparation for their own protection.

It must be remembered that actual trial makes the test, however, and not advertising claims.

Industrial Skin Cleansers

The cleaning of hands and bodies after work is one of the most frequent sources of dermatitis. Personal cleanliness is desirable but the worker's desire to get home quickly and his efforts to remove speedily and completely tenacious soil and dyes from his skin, encourage him to use harsh cleansers. These may contain strong abrasive soaps with high alkaline content and powerful solvents. Dermatitis resulting from this harsh treatment is common and such irritation of the skin may be mistakenly attributed to substances handled while working.

Good but safe industrial cleansers are therefore most important. There are a number of such preparations on the market containing a variety of agents for which special claims, some unjustifiable, are made. Some of these have a physical and chemical action on the skin itself or cause sensitization and produce dermatitis. In addition, the incorporation of gritty material into a cleanser may cause actual trauma with resulting dermatitis or infection.

A safe industrial cleanser should be freely soluble in hard or soft, cold or hot water. It should remove extraneous fats, oil, and other soil without harming the skin or extracting the skin's natural fats and oils. It should not contain harsh abrasives nor irritant scrubbers. It should be handy to use and should not deteriorate or become insect-infested. A normal industrial cleanser for general use should consist of a neutral toilet soap containing a wetting agent or synthetic detergent and a scrubber which softens or dissolves in water and does not clog the plumbing. It should contain a minimum of alkali and have a pH of 10 or less in a one per cent solution. It should contain no silica, quartz, feldspar, pumice, resin fillers or organic solvents.

Type formula for an industrial skin cleanser for general use:

Neutral toilet soap	30
Colloidal clay (Bentonite or Kieselguhr)	30
Santomerse (or other synthetic detergents)	5
Lanolin	2
Perfume	1

Mix colloidal clay and Santomerse. Heat soap and lanolin, and mix with the above.

This may be pressed into cake form, or 32 parts of corn meal may be added to make up 100 parts and the mixture then made into a powdered soap. A mixture of equal parts of potassium-coconut oil soap and sulfonated castor oil to which one per cent of a synthetic detergent is added makes a good liquid cleanser.

Special Cleansers.—In certain occupations the workers handle dyes, pitch, coal tar, and other materials which are difficult to remove. If gloves are not worn it may be necessary to use stronger cleansing agents than the one described. Whenever this is done, the strong cleanser itself should be washed off with soap and water. After the hands are dry, an emollient such as cold cream or a mixture of 70 per cent lanolin and 30 per cent castor oil should be rubbed into the skin.

Soap Substitutes.—For those workers who have dry, cracked and inflamed skins, or whom soap irritates, a soap substitute is necessary. A good soap substitute consists of a neutral sulfonated castor oil to which has been added a wetting agent such as 2 per cent Duponol.

TREATMENT

The treatment of industrial dermatitis depends upon whether the dermatitis is acute, subacute, or chronic. The principle to remember is that *nothing which is in itself an irritant and may make the condition worse* should be used on an inflamed skin.

The first rule is to protect the worker from further exposure to the particular substance which has been causing his dermatitis; this, as will be seen later, does not mean that all workers with dermatitis should be taken off the job. See section on *Prevention*, particularly, *Protective Clothing*.

For *acute inflammation* manifested by erythema and vesicles, wet dressings usually provide the most relief. The best materials for wet dressings are boric acid solution or liquor aluminii acetatis (Burow's solution) 1:20. Such wet dressings should be kept on until the acute inflammation subsides, then mild ointments such as boric acid ointment, calamine ointment, petrolatum, zinc oxide ointment, Lassar's paste (without salicylic acid) can be used.

For the *dry chronic cases* some form of tar is often helpful and among those which may be used are ichthyol 3–10 per cent, or crude coal tar 3–5 per cent in a base of petrolatum, zinc oxide or cold cream. Soap and drastic hand cleansers should be avoided and instead one of the soap substitutes should be used. See section on *Prevention, Industrial Skin Cleansers*.

Dry hands should be anointed with a softening cream after washing and at night. A good emollient consists of equal parts of lanolin and cold cream, U. S. P.

We have found it better to allow patients with mild cases of acute occupational dermatitis to remain on the job under treatment for a week or two rather than to remove them from the job. If they get well under these conditions, they usually become "*hardened*" and are able to continue work without any further trouble. If they do not recover or become worse, they should be removed from the job and treated until they do get well. Even some of these workers can be returned to their former work without developing any further trouble. Those workers who have recurrent attacks of dermatitis should be removed from that particular operation and placed at tasks where they do not come in contact with the irritant to which they are sensitive.

SPECIFIC IRRITANTS

Cutting Oils

Dermatitis from cutting oils, solvents, and degreasers occurs in practically all plants manufacturing armament and ammunition. They are the chief causes of dermatitis in the manufacture of motors, tanks, large and small army shell casings, projectiles, and airplanes.

Cutting oils are used to assist in the cutting of metals, and are the most frequent cause of dermatitis among machine and metal workers. Lubricating oils, greases and rust preventives may produce the same type of lesions.

Cutting oils are divided into two large groups—soluble and insoluble. The principal function of soluble oils is to cool the cutting tools so that they do not lose their temper and break or chip. Their secondary function is lubrication. *Soluble cutting oils* are diluted with many times as much water (1-100) and allowed to flow over the cutting operations. They consist of sulfonated mineral and fatty oils, 60 to 95 per cent; soap, 5 to 30 per cent; and volatile contents, 0 to 10 per cent. Inhibitors such as phenolic amines are often added to prevent rancidity. Despite this fact, soluble cutting oils after use, teem with organisms, some of which are pathogens. Nevertheless, dermatitis, folliculitis, and infections are comparatively rare among workers using soluble cutting oils.

Insoluble oils are used mainly as lubricants, aiding the tools in the cutting operation. The insoluble type of cutting oil con-

sists principally of 55 to 100 per cent of mineral oil, 0 to 30 per cent fatty oil, 0 to 10 per cent sulfur, and 0 to 7 per cent chlorine in the form of chlorinated hydrocarbons. The fatty oil content may be oleic acid, lard oil, fish oils, and vegetable oils. They may have inhibitors incorporated to prevent rancidity. In general, insoluble cutting oils are sterile, and the addition of antiseptics for bacterial control is unnecessary, and may cause skin irritation.

Action on the Skin.—After being used, cutting oils contain many metal slivers which may wound the skin. Skin wounds may also occur from old waste impregnated with the slivers if such waste is used for wiping the oil from the hands.

The petroleum oils have the property of *defatting the skin*, a property which is in inverse proportion to their viscosity. This action is somewhat modified by the animal or vegetable contents of the oil.

All oils may *plug the pores* of the skin and form comedones. Secondary infection may cause folliculitis and boils. Sulfur and sulfur compounds may cause a dermatitis, as may any rancid animal and vegetable oils. Phenols, cresols, nitrobenzene and other inhibitors, though not in sufficient quantity to act as primary irritants, may act as *sensitizers* and cause allergic eczemas. The heat of the cutting operations themselves causes certain chemical changes in the cutting oils, generating such compounds as H_2S , SO_2 , and others. Such compounds not only impart an offensive odor but also act as skin irritants.

The *type of skin* has a marked influence on the workers' susceptibility to dermatitis from cutting oils. A greasy skin having active sebaceous glands is less likely to be defatted than is a dry skin, but it is more likely to develop comedones, folliculitis and acne; a smooth hairless skin is less likely to develop comedones.

Comedones of the hands and fingers occur in handling cutting oils unless the workers are particularly careful in washing their hands after work. Folliculitis and acne are the most frequent types of dermatitis caused by cutting oils, generally occurring on the extensor surfaces of the forearms and thighs where oil-soaked garments have closest contact with the skin. Infected follicles may develop into boils and even carbuncles while wounds of the skin caused by metallic slivers may become secondarily infected with resultant cellulitis.

Those cutting oils which contain chlorinated hydrocarbons cause *folliculitis, acne, and cysts of the face*. On uncovered parts

of the body they cause lesions identical with those caused by chlornaphthalenes, chlอร์ดิphenyls, halowax, chlorbenzols, and other substances. Especially does this occur when the cutting operation produces sufficient heat to cause the oil to fume. In some cases the fumes are so heavy that a dense mist forms around the cutting process. Prevention of dermatitis and chloracne consists in drawing away the fumes through an exhaust, protecting the workers with sleeves and aprons, and applying protective ointments to the face.

The defatting action of the cutting oils on the skin may cause *drying, cracking and fissuring*. These open fissures are similarly subject to secondary infection and may lead to cellulitis, lymphangitis, and even septicemia. Some mineral oils have keratogenous properties and cause small flat brownish *papillomata* on the hands, arms, and other parts touched by the oil or oil-soaked clothing. Approximately 10 per cent of all workers in oils and greases develop these growths. They are usually not troublesome and are often completely ignored by the worker.

Allergic eczemas are the least frequent type of cutting oil dermatitis. They are caused by hypersensitivity to the animal or vegetable oil, the inhibitor or the added disinfectant.

Important causes of dermatitis are the agents used by the workers to cleanse the skin after work. Among these irritating substances are harsh soaps such as sand soaps and those containing a high percentage of alkali; bleaches (even bleaching powder); and various solvents such as kerosene and gasoline. See section on *Prevention, Industrial Skin Cleansers*.

Differential Diagnosis.—The acne from cutting oils must be differentiated from ordinary acne vulgaris. Acne vulgaris occurs principally on the face, chest, and back, and usually among adolescents. Cutting oil acne occurs in all ages and appears on the parts exposed to oil such as the forearms and the anterior part of the thighs. In younger men and women, cutting oil lesions may be superimposed on an acne vulgaris.

Folliculitis and boils from cutting oils must be differentiated from those of non-occupational origin. Cutting oil folliculitis usually occurs on the extensor surfaces of the forearms and thighs while pyogenic infections may occur anywhere. In addition, occupational boils are usually multiple and oil comedones are present.

In differentiating the allergic eczematoid type of cutting oil dermatitis from eczemas of non-industrial origin, patch tests

with the oil are often helpful. Such tests if positive should be followed by a patch test with each of the ingredients of the cutting oil to determine the actual chemical in the oil to which the worker is sensitive.

To *patch test* with cutting oil, soak a piece of gauze $\frac{1}{4}$ inch square and 4 ply thick with cutting oil, apply it to the normal skin, cover it with cellophane 1 inch square, and this with adhesive plaster 2 inches square. Allow to remain on for 48 hours and then read reaction. See section on *Diagnosis, The Patch Test*.

Treatment.—Comedones, folliculitis, and boils caused by cutting oils are treated like those from other causes, that is, by cleanliness and antiseptics. Cleanliness consists of frequent changing of work clothes and frequent washing of the parts affected. The allergic types of cutting oil dermatitis are best handled by removing the affected worker from contact with cutting oils and then treating the dermatitis. Wet dressings of boric acid or liquor aluminium acetatis (Burow's solution) 1:20 are best for the acute moist types while boric acid ointment, zinc ointment, and Lassar's paste, are suggested for the dry states or dry eczematoid types. For dry defatted skins, an emollient such as lanolin 70, castor oil 30, perfume 1, should be given to the worker to rub into his hands after work. See sections on *Treatment*, and *Prevention*.

Prevention.—The best prevention is in cleanliness of person, clothes, machines and oils. For personal cleanliness the workers should have access to adequate washing facilities with hot and cold water and showers. They should be compelled to use them under supervision. Suitable industrial cleansers should be provided and placed in convenient locations in the wash rooms. See section on *Prevention, Industrial Skin Cleansers*. An emollient cream should also be available for those having fissured skins. See section on *Prevention, Protective Ointments*. Clean rags or clean waste should be freely supplied to the workers. Rags should be so laundered that all slivers are removed; used waste should be discarded. Clean work clothes should be provided at least once a week and the anterior surface of the body and thighs should be protected by aprons, and the arms by sleeves made of impervious materials such as Pliofilm, Neoprene, and oil cloth. See section on *Prevention, Protective Clothing*.

The machines should also be kept clean. Insoluble cutting oils should be screened, centrifuged, and neutralized after 150

hours of use. Additional antiseptics should not be added because they also increase the irritating properties of the oil.

Since folliculitis and acne are the most frequent types of occupational dermatitis caused by cutting oils, cleanliness is much more important in prevention than are protective ointments. When protective ointments are used, however, they should be of the type that will fill the pores of the skin with an innocuous vegetable or animal fat, thus preventing the entrance of the mineral oil. Such fats will also help to prevent defatting. See section on *Prevention, Protective Ointments*. The water soluble invisible glove type of protection may also be used. An educational program with occasional talks by the plant physician and striking posters in strategic spots may help in decreasing the dermatitis hazards from cutting oils.

The soluble cutting oils rarely cause acne or folliculitis notwithstanding the fact that they are heavily infected with pathogenic organisms. The addition of disinfectant to soluble cutting oils for esthetic purposes is not discouraged. Allergic eczemas occasionally occur from soluble cutting oils, probably caused by the sensitizing inhibitors, volatile contents, and fatty oils which they contain. The protective clothing advocated for use against the insoluble oils is also of value against the soluble oils.

In some operations like shell drawing, lubricants or coolants are used which contain no oil. They are alkaline solutions, either soap, or a weak solution of sodium carbonate or trisodium phosphate or mixtures of these. Dermatitis occasionally occurs from these alkalis. Protective clothing is recommended for its prevention. The protective ointment containing an innocuous animal or vegetable fat may also be used.

Dopes, Paint Thinners, Degreasers, and Other Solvents; Electroplating and Welding

Solvents have a defatting action on the skin which may eventually cause dermatitis. Those workers who have the least amount of natural oil in their skin are most likely to be affected.

Among the solvents used in war industries are the dopes used in spraying the wings and the control parts of airplanes, the petroleum distillates, turpentine, and other paint thinners. The petroleum distillates such as kerosene and Varsol are frequently used to remove grease from small metal parts. To make matters worse, in many instances these solvents are applied by the bare hands. In addition to solvent properties, certain of the above

materials may also be sensitizers, and workers after becoming sensitized may develop dermatitis from quantities so small that they would not have caused dermatitis before sensitization occurred.

Dopes.—These solvents are painted on the fabric parts of airplanes such as the wings and controls to make them impervious. The dopes are often applied by hand brushes but may also be applied by spray. They consist essentially of a solution of cellulose nitrate or acetate in a volatile solvent such as acetone or amyl acetate which after evaporating leaves the resin on the fabric. The dopes have a defatting action on the skin and can cause dry chapped hands, fissures, and chronic eczemas. A small percentage of workers becomes sensitized and develops acute eczematoid types of dermatitis of the hands, arms, face and whatever portions of the body may be exposed to the solvents or their fumes. Workers exposed to dopes should wear protective clothing and use the mildest of cleansers and apply emollients to their hands after work. See section on *Prevention*.

Paint Thinners.—Painting is usually done by the spray method in vented booths. Exhausts are used to get rid of the vapors which are frequently pulled through a sheet of water to collect some of the ingredients. Paints consist of a pigment (zinc chromate), a drying oil (linseed oil) and a thinner. Turpentine and petroleum distillates are the principal thinners. The paint may also contain a resin. Dermatitis may result from the defatting and sensitizing actions of the thinner or from hypersensitivity to the resin and the pigment or a combination of all. Workers sometimes use paint thinner or other solvents to remove quickly dried paint from the hands. This practice should be discouraged because it is often the cause of dermatitis and the dermatitis is frequently wrongly attributed to the use of the paint.

Prevention of dermatitis from thinners, solvents, and dopes consists of proper exhausts so that irritant fumes are drawn away from the worker. In addition, workers should wear protective clothing especially leather or synthetic rubber gloves, apply protective ointments, and use emollients after work. See section on *Prevention*.

In performing patch tests with paint, a piece of gauze, as described under *Cutting Oils*, should be saturated with the paint, allowed to dry and then applied as a patch test for 48 hours. The wet paint should not be applied as a patch test, because the solvent if not allowed to evaporate is a primary skin irritant.

Degreasers.—Degreasing tanks are used in many industries. The tanks generally contain trichlorethylene and should be so constructed that the fumes cannot escape. Covers of degreasing tanks should be kept closed when not in use and workers should wear protective gloves, sleeves and aprons made of material not affected by trichlorethylene.

Rust Preventives and Metal Preservatives.—Because of long distance hauling, storage time, and varying climatic conditions encountered in modern warfare, measures are necessary to protect metals from rust and scratches. The same holds for automobile and airplane engines and various types of armament. The rust preventive compounds consist essentially of petroleum oil, or grease and an inhibitor similar to the inhibitors used to prevent rancidity in cutting oils. Bright metal sheets such as duralumin and Dow metal may be coated with a resin or oil to prevent scratch marks. This coating may contain fish oil. (Allergic dermatitis in an airplane factory among workers handling duralumin was traced to the "fish oil" content of the metal preservative.)

Rust preventives and metal preservatives may cause dermatitis. The physician must be on his guard because a dermatitis can occur unexpectedly among workers in widely separated processes and among those far from where the original rust preventive measures were used. Thus, it might occur not only among workers spraying rust preventives at the factory, but also among stevedores handling machines and motors in transit or among workers where the pieces are being unpacked and re-assembled. The dermatitis may be similar to that caused by cutting oils, namely folliculitis and allergic eczema. Moreover, solvents are used to remove the rust preventives and they produce their particular type of defatting dermatitis. Protective clothing and ointments, described under *Cutting Oils*, are helpful. See sections on *Treatment and Prevention*.

Electroplating.—Electroplating is primarily a rust preventive process. Chromium and cadmium are the principal materials used, but silver, zinc, copper, and nickel are also frequently employed. In addition, there are a number of rust preventing processes, such as parkerizing, chromadizing, and anodizing. In all these processes the tanks contain strong alkaline or acid fluids which give off irritant fumes. Ulcers of the nasal septum resulting in nose bleeds and even perforation are common. Dermatitis is frequent from mist and fumes coming off the alkaline, chromic

acid, dichromate and cyanide solutions in the plating tanks. Dermatitis also occurs among those who clean the metals with strong acids and alkalis prior to electroplating and among those who handle the wet metal from the plating tanks.

The worker's nasal mucosa should be protected with ointments like lanolin or vaseline (*never carbolated*, because of possible harmful reaction from the phenol). Protective garments should be worn. See section on *Prevention, Protective Clothing*.

Welding.—Welders and solderers are exposed to irritating fumes. Welding of stainless steel and aluminum alloys requires fluoride fluxes which evolve fluorides and hydrofluoric acid fumes. If not properly removed by suction vents, fumes may irritate the nasal mucosa or skin. The nostrils should be protected with non-carbolated vaseline or lanolin. The skin must also be protected. See section on *Prevention*.

Tetryl

Trinitrophenylmethylnitramine, called tetryl, will sensitize, and cause dermatitis in from 10 to 15 per cent of all new workers, one to two weeks after they begin handling it, although in a few cases it may require several months for sensitivity to become manifest. Workers coming in contact with the dust from dry grains of tetryl and from tetryl pellets are more frequently affected than those handling wet tetryl.

Symptoms and Diagnosis.—Those exposed to the dust may first develop nose bleed or bloody discharge from the nose. The nasal mucous membrane becomes turgid, and small superficial erosions may sometimes be seen. Distinct ulceration of the mucosa has not been observed. On those exposed to dry tetryl, the dermatitis usually begins on the face. The nasolabial folds and the skin under the lower eyelids are first affected. There may be sufficient edema to close the eyes. The skin may be blistered and have the appearance of a second degree sunburn.

In isolated cases or where the history of working with tetryl is not known, it may be attributed to cosmetics used on the face or hair. The hands and other portions of the body coming in contact with tetryl will be discolored a yellowish brown. These parts may also be inflamed. In some operations where small amounts of tetryl are handled and where there is but little dust, the hands and arms may be first affected. The hair is stained a reddish brown in brunettes and a yellowish red in blondes. In some cases the genital and anal regions become stained and even

inflamed because they are touched by tetryl soiled hands. Favorite sites of dermatitis are points of friction such as the collar line, the wrists, the portion of the face touched by respirators, and the areas on the hands where the coarse seams of heavy or poorly fitting gloves rub the tetryl into the skin.

To perform *patch tests* with tetryl, place a small amount of the powder on a piece of gauze about $\frac{1}{4}$ inch square and 4 plies thick slightly moistened with acetone. Apply to the normal skin, cover with a piece of cellophane 1 inch square, and this with a 2 inch square piece of adhesive plaster. Allow to remain on for 24 hours, and then read the reaction. Read again 3 days later for delayed reactions. The gauze may also be moistened with a saturated solution of tetryl in acetone, allowed to dry, and applied as a patch test.

Prevention.—Operations where there is much tetryl dust should be properly vented. Workers at these operations should be supplied with soft washable leather gloves, and impervious sleeves and aprons, as well as with a protective ointment. The following formulas have been found to be good protective ointments against tetryl:

No. 1	No. 2
Shellac 13	Casein 20
Isopropanol 31	Zinc oxide 20
Linseed oil 4	Yellow oxide of iron... 2
Titan. oxide 12	Water 58
Sod. perborate 13	
Talcum 20	
Carbital 3	

Allow to stand for 48 hours and decant the fluid accumulated over the surface before using the ointment.

The ointment can be applied to the face and hands before going to work, removed at lunch and reapplied after lunch. The workers who make primers, detonators, and boosters containing tetryl should be supplied with light chamois washable gloves as well as with sleeves and aprons. If for any reason gloves cannot be worn, the protective ointment can be used. All workers need not use these protective measures. Only new workers and those who are sensitized to tetryl need take all these precautions. The worker who has been exposed for a long time without taking these precautions and has not had dermatitis need not do so; neither need the worker who has become "hardened" or immune following an attack of tetryl dermatitis. Supervised showers

after work should be compulsory for all workers exposed to tetryl.

Treatment of Tetryl Dermatitis.—Mild cases of tetryl dermatitis, that is, cases with little edema of face and eyes may be permitted to continue work and can be given wet dressings of boric acid or aluminum acetate to use at home, and boric acid ointment or zinc oxide ointment to use while at work. Only severe cases or those who cannot get well while at work need to be removed from the job. Most cases get well while working (hardened) and can continue work without further trouble. About 50 per cent of those who are taken off the job in order to get well can also return to work without further trouble. The others must be kept away from tetryl.

Tetryl indelibly stains the skin but the stains can be almost entirely removed by continued washing two or three times daily with a 10 per cent sodium sulfite solution, and this followed by soap and water. The staining of the hair can be prevented by wearing impervious caps, but once the hair is stained, it is best not to attempt to restore its color. It is better to prevent further staining by wearing the impervious cap and the new hair as it grows out will not be stained.

Tetryl Manufacture.—Workers at the openings of retorts used for sulfating are exposed to fumes and splashes of sulfuric acid, dimethylaniline and aniline sulfate and should be provided with impervious sleeves, aprons, and gloves.

In the nitrating building workers at the nitrating retort are exposed to hot tetryl, the acids, and nitrous fumes. Men stirring wet tetryl crystals in the tubs and those who transfer the wet tetryl from the tubs to wooden carriers in which it is carried to the refining buildings, get wet tetryl on their clothes and hands, and when the tetryl dries some of the workers develop dermatitis. In the refining building the workers also are exposed to wet tetryl as the refined wet tetryl is shoveled into wooden carriers for transportation to the dry-house. In the dry-house, where the tetryl dust is thick on the floors, walls, windows and the clothes of the workers, the largest percentage of tetryl dermatitis occurs; as many as 50 per cent of these workers may develop tetryl dermatitis. In the packing and boxing buildings where there is considerable tetryl dust generated by the screening operation dermatitis is fairly common among the workers. All workers in the nitrating, refining, drying and packing houses should be provided with protective ointment for use on the face, twice daily. They should also be furnished with soft washable

leather gloves and impervious sleeves and aprons. The sleeves should fasten over the gloves at the wrists. In the packing, boxing and drying houses it may be of advantage to furnish the workers with transparent impervious head and face coverings to protect the face.

TNT

In a work-room where there is TNT dust, the newcomer experiences a bitter taste.

Trinitrotoluene causes sensitization dermatitis in a smaller percentage of new workers than does tetryl. The dermatitis usually begins from 7 to 14 days after work with TNT is begun. It usually attacks the hands, wrists, and forearms, but the points of friction, collar line, belt line, and ankles are also often affected. It is unusual to find TNT dermatitis on the face, but the genitals and the submammary area are sometimes affected from soiled fingers. A generalized eruption may also occur in rare cases. The lesions on the palms are characteristic in appearance; they are deep seated sago-like vesicles and are accompanied by considerable edema and discomfort. As the dermatitis subsides, the skin on the palms peels in large thick pieces leaving new skin beneath. The lesions on other parts are not as characteristic as those on the palms, consisting simply of papules, vesicles, and crusts, followed by flaky desquamation. TNT also stains the skin and discolors the hair but not as much as tetryl. Cyanosis or "blue lip" is fairly frequent among workers exposed to TNT.

Patch tests with TNT may be performed in the same manner as described for *Tetryl*.

The preventive measures including, among other things, protective ointments, clothing, and showers, together with treatment as given for tetryl dermatitis also apply to TNT dermatitis.

TNT Manufacture.—Men working over the nitrating retorts are exposed to fumes and splashes while inspecting and sampling the progress of the reaction. These workers should be furnished with impervious sleeves and aprons, and with leather or cotton lined rubber gloves. The workers in the wash house, flaking house, and packing house should be provided with washable soft chamois or leather gloves and impervious sleeves and aprons.

Fulminate of Mercury

This compound is manufactured from mercury, nitric acid, and ethyl alcohol. It is made up in small batches under carefully controlled conditions. If suitable equipment and adequate exhaust

ventilation are provided, cutaneous exposure need not occur to the basic chemicals, reaction products, or finished compound. Nitric acid offers a potential hazard for burns. The finished mercury fulminate is kept wet and is stored under water until used.

Mercury fulminate, because of its sensitivity, is used principally as a detonator for high explosives and as an ingredient of primer mixtures. When it is to be used, it is first dried in a chamber at a constant temperature and then mechanically screened. The explosive is then delivered in small amounts to the detonator lines, or when used for primers it is mixed with other ingredients such as ground glass, antimony sulfide, potassium chlorate, shellac, and alcohol.

In making detonators, the various operations are carried on by a group of workers as an assembly line type of operation. The operations include, among others, weighing the mercury fulminate charges and placing them in the detonator cup, pressing the charges, removing the excess loose powder (rumbling), and capping and crimping the finished detonator. A certain amount of cutaneous exposure to mercury fulminate dust occurs in most of these procedures and since the workers usually rotate through the various operations, changing approximately every two hours, they all have more or less the same degree of exposure. Most of the dermatitis from mercury fulminate occurs in the workers manufacturing detonators. The number of cases of dermatitis increases during hot weather.

In the manufacture of primers exposure to mercury fulminate dust does not occur because the primer mixture is wet and the workers usually wear rubber gloves or finger cots to protect their hands. These workers, however, frequently get dermatitis of those areas of their forearms which touch the work bench and come in contact with primer mixture that has been spilled and has dried. If the primer mixture is dropped on the clothing it will also become dried out and the dry powder may then work through to the skin. Dermatitis of the abdomen has been seen from primer mixture dropped on the clothes.

Diagnosis.—The dermatitis from mercury fulminate is on an *allergic basis*. The exposed skin areas such as the face, sides of the neck and upper sternal area, antecubital areas and forearms are principally affected. Covered areas may also be involved if the mercury fulminate dust works its way through the clothing.

The inhalation of mercury fulminate dust usually causes *nasal irritation* and some discharge. Frequent wiping of the nose

is often the means of carrying mercury fulminate to this area and when a dermatitis results the alae nasae and peri-nasal areas are involved in an erythematous, weeping, crusted dermatitis. *Conjunctivitis* occurs in a considerable number of those workers making detonators, and the dermatitis may involve the eyelids, accompanied by considerable edema. The dermatitis of other portions of the face, the neck, and antecubital areas is of a similar non-specific eczematoid type. On the forearms and wrists the dermatitis often appears as a scattered papulo-vesicular eruption.

Dermatitis among those workers making primers is usually confined to the forearms for reasons already stated. The fact should not be overlooked that other ingredients of the primer mixture, such as antimony sulfide, may be responsible for dermatitis as well as the mercury fulminate. Patch tests will aid in determining the exact etiology in these cases.

Measures for the prevention of dermatitis from mercury fulminate should be directed toward preventing cutaneous exposure. Such measures have already been described. The insertion of vaseline in the nostrils will afford protection from the nasal irritation produced by mercury fulminate dust.

Patch tests with fulminate of mercury may be performed in the same manner as described for *Tetryl*.

Dinitrotoluene

Dinitrotoluene or DNT also causes sensitization dermatitis but not as frequently as TNT. There is no characteristic appearance to the dermatitis caused by DNT. It is the usual eczematoid dermatitis, with erythema, papules, and vesicles. The sites are usually the wrists, collar line, belt line, forearms, and hands. The prevention, treatment and patch test technique are the same as given for tetryl.

Ammonium nitrate can cause dermatitis, but even in a smaller percentage of workers than does DNT.

Lead Azide

This explosive, like mercury fulminate, is used in detonators and primers. Its manufacture depends on the reaction of sodium azide with lead nitrate or acetate. Fumes given off from this reaction produce headache if inhaled.

Unlike mercury fulminate, lead azide rarely produces dermatitis in those exposed to it in the manufacture of detonators,

primers, and fuses. One patient has been observed with dermatitis who handled a primer mixture containing both lead azide and mercury fulminate. Patch tests with both explosives were positive. The *patch test* technique is the same as that described for *Tetryl*.

Since dermatitis occurs so rarely from exposure to lead azide, special measures for protection of the skin are not indicated.

Smokeless Powder

The finished smokeless powder is rarely, if ever, responsible for dermatitis among those handling it. In the manufacture of smokeless powder there are also very few skin hazards. Workers operating dehydration presses are exposed to alcohol fumes, and dilatation of the blood vessels of the face have been observed in those whose exposure has extended over a number of years.

A double base powder is made by combining nitrocellulose (smokeless powder) and nitroglycerin for use as a propellant charge for trench mortar ammunition. Workers trimming and weighing these charges frequently complain of headaches as a result of systemic effects from the nitroglycerin. The wearing of rubber or washable leather or chamois gloves will reduce the cutaneous absorption of nitroglycerin resulting from handling this explosive.

Black Powder

This explosive is not a single compound but a mixture of potassium or sodium nitrate, charcoal, and sulfur. It is rarely, if ever, responsible for dermatitis among those handling it.

Chemicals Used in War

Dermatitis is of frequent occurrence in the manufacture of war gases. Even those classed as lung irritants, sternutators, lacrimators, and irritant smokes cause considerable dermatitis among workers engaged in their manufacture despite safety precautions. The vesicants, however, are the ones which cause the most severe skin lesions.

Chloracetophenone and Brombenzylcyanide.—These materials, while classed as lacrimators, will cause erythema and papules on the exposed and even covered parts of a considerable percentage of workers. The dermatitis rapidly subsides on cessation of exposure, and upon the application of mild alkaline lotions

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and ointments. Workers should be given daily changes of protective clothing, protective ointments of the vanishing cream type for the face, and gas masks.

Mustard Gas or Dichlorethyl Sulfide.—This is a heavy colorless liquid having a garlic-like odor, and will irritate the skin in as low a concentration as 1–2,000,000. It is said to cause dermatitis by combining with the cell protein. The effects on the skin are not felt until 2 to 6 hours after exposure, depending on the concentration and the length of time of the exposure. The lesion begins as an erythema which soon develops into vesicles, and the fully developed lesions consist of a central area of necrosis around which is a ring of vesicles. Several weeks are required for the lesions to heal and they leave permanent scars. A primary mustard burn will often sensitize so that dermatitis will result from concentrations below the normal minimum.

Mustard gas is manufactured and placed in cylinders by a totally enclosed process. The workers are protected by special clothing impregnated with a chemical to neutralize the mustard gas, because ordinary impervious clothing made of rubber or leather does not keep out the gas. Nevertheless, burns occur even through the special clothing. Chemicals used to impregnate clothing for the purpose of neutralizing the gas are those that give off chlorine, such as calcium chloride, sodium hypochlorite, dichloramine T and those that give off oxygen such as peroxides, perborates, periodates, chlorates, perchlorates, and permanganates. Oiled fabrics and certain synthetic resins will resist the penetration of mustard gas for a considerable period; cellulose acetate, polymerized vinyl chloride, the copolymer of vinyl chloride and vinyl acetate, rubber chloride, and polyvinyl alcohol are some of these. Protective clothing against mustard gas should have the sleeves fastened over the gloves at the wrists and the trousers over the shoes at the ankles to prevent the gas from diffusing up the arms and legs and attacking the axillae, the perineum and the scrotum.

It is said that workers cannot wear clothing made entirely of these impervious resins for any length of time because of the retained body heat and perspiration, but sleeves and aprons made of cellulose acetate and worn over the specially impregnated clothing would not cause intolerable sweating and would prevent a large percentage of accidental burns from drops of mustard gas which are not fully neutralized by the chemical in the protective clothing.

Protective ointments against mustard gas have been prepared but they are not very successful.

Workers with mustard gas should be provided daily with fresh protective clothing and compelled to take supervised showers after work.

The *treatment* of mustard gas burns consists of dabbing the burned areas with absorbent cotton to remove remains of the mustard and then washing with 1 per cent sodium hypochlorite solution. Vesicles should be opened and the lesions treated as thermal burns by the application of such solutions as tannic acid and sulfadiazine, Burow's solution, and triple dyes.

Lewisite.—Lewisite is chlorovinyl-dichlorarsine. It is a heavy colorless liquid having an odor like geranium and will irritate the skin in concentrations as low as 1–1,000,000. It causes burns similar to those of mustard gas, but in a shorter period after exposure, namely, 15 minutes to one hour. It is said to be more rapidly fatal than mustard gas causing death from arsenical poisoning in 3–5 days, if there is sufficient exposure. Workers manufacturing it should have the same protection as described for mustard gas except that the peroxides and perborates are said to be better neutralizers of lewisite than the chlorine compounds. Therefore, the perborate cream prepared by the U. S. Public Health Service against poison ivy should also be suitable as a treatment and preventive against lewisite. Burns should be mopped with absorbent cotton, washed with hydrogen peroxide solution, vesicles opened, and perborate solutions or creams or zinc peroxide in powder form applied.

Ethylchlorarsine.—This chemical also causes a vesiculobullous dermatitis after 15 minutes to one hour of exposure to concentrations as low as 1–200,000. The protective measures and treatment of burns are the same as given for *Lewisite*.

Cartridge Manufacture

Dermatitis chiefly in the finger webs occurs among workers on drawing operations caused by the alkaline coolant which flows in a continuous stream over some of the process. Workers so affected should be given rubber gloves, or an ointment consisting essentially of lanolin 70, castor oil 30, to apply to the hands before and after work.

Workers dipping cartridge cases in mercurous nitrate solution to detect cracks, should wear rubber gloves.

Girls gauging, weighing, inspecting or otherwise handling

cartridges should be provided with canvas or washable chamois gloves to prevent traumatic dermatitis of the fingers and paronychia caused by the metal.

Workers loading tracer bullets are exposed to the irritant dust of the tracer mixture. Nose and throat irritation can be prevented by the use of respirators, and dermatitis by using the protective ointment recommended against tetryl.

Traumatic dermatitis of the thighs caused by bumping or leaning against the sharp metal edges of ammunition trucks can be prevented by padding the edges of the trucks or by having the girls wear pads under their dresses.

Girls coating shellac on paper covers for primer sealing, "foiling," should wear rubber gloves and impervious sleeves and aprons, to prevent dermatitis from the shellac solvent and the primer charge.

Girls loading primers, pass the palms over the loading plates and some develop a deep seated vesicular eruption on the palms resembling that caused by TNT although antimony sulfide may be a contributing factor. These girls should also wear rubber gloves and impervious sleeves and aprons.

Workers in the pre-mix and the primer-mix departments are exposed to the dust of the explosives and should wear rubber gloves, impervious sleeves, aprons, and respirators. Cutting oil dermatitis may occur in the tool and die shop. See section on *Cutting Oils*.

Workers with brass will complain of what they call "brass poisoning." Every cut and every case of dermatitis will be called "brass poisoning" by some of the workers. Slivers of brass cause dermatitis just as slivers of any other metal by wounding the skin. Secondary infection of these wounds may occur as in wounds from any other metals. Actual sensitivity to brass has not been demonstrated.

Shell and Bomb Loading

Workers in plants where shell loading, bomb loading, trench mortar shell loading, and renovating of projectiles are performed, are exposed to skin hazards not only from all the explosives used but also from the solvents used for degreasing and for paint thinners.

Tetryl.—Tetryl may cause sensitization dermatitis usually on the face five days to several months after work is begun. It will stain the skin and hair a yellow color and will cause nose

bleed. Workers engaged at weighing, screening and blending tetryl are exposed to large quantities of tetryl dust and should be provided with clean work clothes daily. They should insert lanolin or vaseline into the nostrils several times a day to protect the mucous membranes. They should be provided with a protective ointment to use on the face, arms, and hands. If rubber gloves or soft washable leather gloves, impervious sleeves and aprons are worn, the protective ointment need not be applied to the hands and arms. Showers after work should be compulsory.

Workers engaged in making tetryl pellets are exposed to tetryl dust when filling and cleaning the hoppers and when handling the finished pellets. They should be protected with protective clothing, ointments, and compulsory showers as described in section on *Tetryl*. Workers loading boosters with tetryl pellets or filling small bags with tetryl, and those placing the boosters into shells, as well as those placing tetryl into hand grenades and into fuses are all exposed to tetryl dust and should be protected as described above.

TNT.—TNT may cause sensitization dermatitis after five days to several months of exposure; it stains the skin and hair a yellow color, but not so pronounced as does tetryl. While TNT does not cause nose bleed, it often causes cyanosis or "blue lip." TNT usually attacks the hands, but cases of generalized dermatitis may also occur. Workers engaged in weighing, screening and sifting TNT are exposed to considerable TNT dust. They should be furnished clean work clothes daily, and showers should be compulsory and supervised after work. Impervious sleeves and aprons, and soft washable chamois or leather gloves should be provided and washed daily. (Steeping the gloves in a 10 per cent solution of sodium bisulfite followed by several rinsings in water decontaminates them.) A protective ointment, as described under *Tetryl*, may be applied to the face and other exposed parts. Workers melting TNT and those pouring it into shells and bombs, as well as the tappers and drillers, should be given the same protection as described above.

Folliculitis and boils sometimes occur on the hands and arms of workers with molten TNT and are caused by the crystallization of the TNT as it cools, and the enmeshing of the hairs. When the crystals are pulled off the skin, the hairs are pulled out and infection may result. Protective clothing will prevent this.

Dinitrotoluene.—Dinitrotoluene (DNT) is used in smokeless powder. While it causes sensitization dermatitis it does not affect

as many workers as does TNT, nor are the cases as severe. The preventive measures are the same as for *TNT*.

Fulminate of Mercury.—Fulminate of mercury is used in detonators and primers, and affects a considerable percentage of the workers. Even when handled wet, as it is in detonators, it will dry on the clothes, sift through, and cause dermatitis on the covered parts, such as the abdomen and the chest. Soiled fingers may carry it to the genitals and cause dermatitis on those parts.

Fulminate of mercury is also used in primers when it is mixed with antimony sulfide, potassium chlorate, and ground glass. The dermatitis among workers filling primers may be caused by the fulminate of mercury or the antimony sulfide, or both. Patch tests with the primer ingredients will determine the actual irritant. The protective measures recommended are those given for *Tetryl* or *TNT*.

Ammonium Nitrate.—Ammonium nitrate used with TNT to make amatol is a relatively mild skin irritant, and workers protected against TNT are protected against ammonium nitrate.

Lead Azide.—Lead azide is used only in small quantities. Dermatitis from it may occur, but is rare.

Patch Tests.—In the performance of patch tests the explosives can be applied to the skin in powdered form on a piece of gauze and allowed to remain for 48 hours. Late reactions should be looked for up to 3 days after removing the patches.

Solvents.—Solvents are used to a large extent in cleaning and degreasing shells, in spray gun stenciling, and in renovating old projectiles. Kerosene, petroleum spirits, Stoddard solvent and oakite are some of the solvents used, and all can cause dermatitis by their defatting and keratogenous action on the skin. Workers in contact with such solvents should wear solvent-proof gloves, sleeves, and aprons. If for any reason these cannot be used, protective ointments, special cleansers and emollient creams should be supplied to the workers. Workers should not be permitted to dip the unprotected hands in these solvents. See section on *Prevention; Protective Ointments, and Cleansers*.

Asphalt Paint.—Girls using asphalt paint on primers should be provided with synthetic rubber gloves, or if this is not feasible a protective ointment and a special skin cleanser to remove the paint from the hands.

Finger cots should be provided for workers loading cartridges with smokeless powder, and for those spring-arming fuses, to

protect them from cuts from the silk cords and scratches from the spring.

Airplane Manufacture

The principal skin hazards are from thinners and solvents used in paints and dopes, from chemicals used in rustproofing metals, fluxes used in welding, solvents used for cleaning and degreasing, and cutting oils, protective oils, and resins used on dural. The principal protective measures consist of wearing impervious clothing, and the use of protective ointments, and non-irritating skin cleansers.

Dermatitis which occurs in the manufacture of airplanes is sometimes called "dural poisoning" by the workers, but no cases of dermatitis caused by the alloy itself were found among over one hundred thousand workers. Nor were there any cases of magnesium gas gangrene encountered or reported. Dermatitis was seen from the so-called "fish oil" which is used to coat dural sheets for shipment. These cases occurred among workers who handled the cut sheets of metal before the oil was washed off. The varnish with which some dural sheets are sprayed to protect them from scratches may also cause sensitization and dermatitis. "Line oil" consisting of spent varnish, resins, and oil dissolved in Stoddart solvent, is also used to coat dural to protect it against scratches and may cause dermatitis. The dermatitis caused by the protective coatings for dural may be prevented by having the sheets cleaned before workers handle them. Men employed at cleaning the sheets should wear rubber boots, gloves, aprons, and sleeves.

The workers in the anodizing, cadmium plating, and other rust proofing departments should wear long rubber gloves over which sleeves of impervious materials are fastened at the wrists, and aprons made of similar material, to protect them from dermatitis which may be caused by splashes of acids, dichromates, alkalis, and solvents, used in these departments.

Workers exposed to dopes should wear fabric lined rubber gloves over which sleeves of impervious fabrics should be fastened at the wrists. Workers who develop sensitization dermatitis of the face should apply a protective ointment of lanolin 70, castor oil 30, to the face and neck.

Drop hammer and hydraulic press operators should wear leather or canvas gloves and impervious sleeves and aprons to protect them from the oils and greases used on the ropes, dies, and metal plates.

Workers in the "heat treatment" department should wear impervious sleeves and aprons and insert vaseline into the nostrils to protect against dermatitis and nasal ulceration from cyanide dust. The same applies to workers over tanks containing hydrofluoric acid used to etch metal parts and for coating dural, preparatory to spot welding. Workers in the machine shops should be protected against cutting oils and solvents. See sections on *Cutting Oils and Solvents*.

Workers at the magna flux machines should wear vinylite or synthetic rubber gloves, sleeves, and aprons to protect them against dermatitis from the kerosene and Stoddart solvent.

Workers in the paint shop who are sensitive to the paint thinners and particularly those who must paint with hand brushes should wear impervious sleeves, gloves, and aprons and apply a protective ointment of lanolin 70, castor oil 30, to the face and neck.

Welders and solderers using fluoride fluxes or zinc chloride, or workers applying hydrofluoric acid to metal plates for spot welding should wear impervious sleeves and aprons and insert vaseline in the nostrils.

Dermatophytosis

Of importance because of its frequent confusion with or as a complication of industrial dermatitis is dermatophytosis (athlete's foot). The salient symptoms are itching between the toes, the instep, and on the soles, or on the palms and the sides of the fingers. Small vesicles, some of which may be deep seated, appear at the sites of the itching. Later there may be a mass erosion of the skin between the toes, especially the fourth and fifth, with soggy desquamation and a characteristic odor. The eruptions on the hands are thought by some to be a sensitization from an original focus on the feet, and are called dermatophytids; they go on to scaling and eczematization.

There are many effective methods of treatment, if used with good judgment, depending for their efficiency on the location and stage of the disease. Treat the patient rather than the case. More harm is done by over-treatment than by under-treatment. The most frequent sources of over-treatment are the improper uses of strong medicaments, the commonest of which is Whitfield's Ointment.

Principles of Therapy.—In acute vesicular cases, soak the feet for 15 minutes twice a day in an antiseptic solution, such as 1:3000–5000 potassium permanganate, and follow by thorough

drying and powdering with a bland talcum powder. With a more chronic condition, the use of mild ($\frac{1}{2}$ strength) Whitfield's Ointment is helpful. The full strength of Whitfield's Ointment should not be used for more than a week, or until the epithelium is peeled off, and then followed by a bland ointment, such as zinc oxide, until the inflammation subsides. The antiseptic coal tar dyes, gentian violet and brilliant green in 2 per cent solution have also given good results. It is usually impossible for the hands to recover until the infection has been eradicated from the feet. Often treatment of the feet alone will be followed by disappearance of the lesions from the hands without any definitive local therapy. But in most cases, the phytids on the hands are benefited by Lassar's paste with 2 per cent salicylic acid, or some mildly stimulating ointment or keratolytic.

Secondary infection in scratches or in the fissuring between the toes may occur and is usually controlled by wet dressings and rest.

Important in *prophylaxis* and *prevention of reinfection* is foot hygiene. This consists of not going barefoot, and of thoroughly drying the feet, especially between the toes after a bath, and the application of a drying powder. Powders which contain a mild antiseptic are useful and available, but thorough drying and the use of any bland talc is helpful. It is important to have workers wear wooden sandals or some form of individual foot protection while walking from locker rooms to showers and back, and not to take them off even in the showers. In this way the infection cannot be contracted or spread. It is useless to have antiseptic foot baths in front of the showers if the worker is to walk barefoot to and from the antiseptic trough. The importance of wearing clean stockings daily and disinfecting old shoes which may harbor the fungi must not be overlooked.

PERSONNEL ASPECTS

Selection of Workers

A considerable proportion of occupational skin diseases may be avoided by the proper selection of workers. Thus, individuals with a known hypersensitive skin as shown by neurodermatitis, allergic manifestations, or history of atopy or infantile eczemas should not be employed in skin hazardous occupations. Neither should those with dry skins be employed at jobs where they must wet the hands in solvents. Nor should cases of marked acne be

subjected to contact with cutting oils. Negroes are usually more resistant to many skin irritants than are whites.

In the rush of war employment it is often impossible to be as selective as one would wish but whenever selection according to type of skin best suited for the particular skin hazard is possible, it should be attempted. An actual trial of the employee at work might be made, because many individuals are able to work when clinical judgment suggests that they may not be able to.

Preemployment patch tests are not advocated because the workers do not become sensitized until after a certain period of exposure, and a negative preemployment patch test does not mean that the worker will not become sensitized to one of the substances with which he works. Neither will a patch test tell whether the sensitized person will become immune or "hardened." Besides, there are legal complications to preemployment patch testing.

Education of Workers

Education of the workers by the physician or safety directors in a factory is helpful in preventing a certain proportion of skin irritations. Simplicity in talking and explaining the skin hazards is necessary. Matters to be stressed are personal cleanliness, frequent changes of clothing, and the use of only properly tested cleansers. The display of humorous satirical or other educational cartoons in washrooms and other strategic sites is often of aid. A rounded educational campaign of prophylaxis may be well worth the extra effort involved.

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CHAPTER 11

ENGINEERING CONTROL OF AIR CONTAMINATION OF THE WORKING ENVIRONMENT

Allen D. Brandt, D.Sc.

WHEREVER materials are being processed, whether changing the physical or chemical state or the physical size, some of the materials in form of dusts, fumes, mists, gases, or vapors will escape into the air of the workroom with the exception of those rare cases where the processing is done in an air-tight system. Even under these conditions, some air contamination will result when the various parts of the system are serviced or repaired. From the point of view of industrial hygiene, these contaminants may be differentiated as follows:¹

Dusts: Solid particles generated by handling, crushing, grinding, rapid impact, detonation and decrepitation of organic or inorganic materials such as rock, ore, metal, coal, wood, grain, etc. Dusts do not tend to flocculate except under electrostatic forces; they do not diffuse in air but settle under the influence of gravity.

Fumes: Solid particles generated by condensation from the gaseous state, generally after volatilization from molten metals, etc., and often accompanied by a chemical reaction such as oxidation. Fumes flocculate and sometimes coalesce.

Mists: Suspended liquid droplets generated by a condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, and atomizing.

Gases: Normally formless fluids which occupy the space of enclosure and which can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Gases diffuse.

Vapors: The gaseous form of substances which are normally in the solid or liquid state and which can be changed to these states either by increasing the pressure or decreasing the temperature alone. Vapors diffuse.

Some of the air contaminants such as benzene,² lead,³ mercury,⁴ and silica⁵ are very harmful to exposed workers while others such as acetone, coal dust, calcium carbonate, and magnesium oxide are relatively nontoxic. However, even for those relatively harmless contaminants, which are classified as nuisances, there is a degree of atmospheric contamination which should not be exceeded lest the health of the exposed workers be affected adversely. To insure the utmost efficiency from all work-

ENGINEERING CONTROL OF AIR CONTAMINATION

ers, it is necessary that the degree of contamination of the inspired air be maintained at a value which is known to present no harmful effects or in the absence of specific knowledge on the toxicity of the contaminant, the atmospheric concentration should be kept as low as is feasible with good engineering practice.

GENERAL CONSIDERATIONS

Control of atmospheric contamination is primarily a responsibility of the industrial hygiene engineer and may be accomplished by means of one, or more than one, of the following methods: (1) control at point of generation or dissemination, (2) dilution with uncontaminated air, (3) isolation of those processes which produce contamination, (4) substitution of less toxic materials, (5) reduction of the concentration of contaminant in the inspired air by means of respiratory protective devices, and (6) maintenance, housekeeping, and the education of the worker.

Very rarely do we encounter an operation where toxic materials are processed—and *practically all air contaminants are toxic if the concentration is high enough*—that may be controlled efficiently by only one of the above methods; a combination of several methods is usually most effective and practicable.

Control at Point of Generation or Dissemination

The methods commonly used to control atmospheric contaminants at their point of origin are (1) local exhaust ventilation, (2) wet methods, and (3) good housekeeping.

Local Exhaust Ventilation.—Of the various methods of control of air contamination, this is the most important single method. Few are the industries where local exhaust ventilation is not employed in one form or another and in some large industries the complete local exhaust ventilation system is almost as extensive as the production equipment. In new buildings the ventilation system should form part of the structure and equipment, if the best results are to be accomplished. If the ventilation system is designed and installed after the building and equipment installation have been completed with little or no thought having been given to a ventilating system, the ventilating engineer is handicapped tremendously and at best cannot do a good job. Consideration must be given to the location of those operations which liberate toxic materials into the atmosphere as regards, among other things, doors and windows, other ~~similar equipment~~, and densely populated areas.

A local exhaust ventilation system consists essentially of four parts, as follows: (1) hoods or enclosures, (2) air ducts, (3) collector, and (4) exhausters.

1. *Hoods or Enclosures.*—Of the four parts, the hoods or enclosures are probably the most vital. The purpose of the hood is to enclose the contaminant or to produce air movement at the source of contaminant production of suitable magnitude and acting in the proper direction to capture the escaping contaminants and convey them into the exhaust system. A thorough knowledge of the laws of air flow into suction openings and of the way in which the various contaminants react is essential to the design of an efficient hood. A hood is efficient when it collects effectively the contaminant with a minimum of air removal, and is of proper design when it is efficient and does not hinder the operation of the tool or machine.

While the *design* of a good hood involves many considerations, the following specific rules should be kept in mind at all times: (1) Enclose the source of contamination as much as possible, (2) locate the hood in line with the natural direction of movement of the contaminant or contaminated air, (3) locate hoods, which do not enclose source of contamination, as close to the source as possible, and (4) for hoods which must be located at some distance from the source of contamination, use as large hood openings as practicable and flanges, if possible.

The *velocity of air movement* at the source of contamination necessary to capture the contaminant may vary from as little as 75 to 100 feet per minute (f.p.m.), a velocity sufficient to overcome normal air currents at the surface of an evaporating liquid, to as high as 2000 or more f.p.m. at a high velocity dust producing machine such as a "jack hammer." Table 1 will serve as a guide in the selection of the proper minimum control velocity for any operation, and shows that the minimum control velocities for the great majority of operations are in the range of 75 to 300 f.p.m. Even though these velocities will do a satisfactory job if the operation is carried out as intended, and if other adverse influences are prevented, it is very easy to create conditions which will render the local exhaust system ineffective. For instance, any unusual motion in the area of the source of contamination will interfere with the control air currents created by the hood and render the control ineffective. Also opening doors or windows near a local exhaust hood on a moderately windy day will impair the effectiveness of the control. To obtain a clearer

picture of the importance of this particular item, namely, that the operation be carried out as intended when the hood was designed and that all adverse influences be avoided, it is only necessary to reflect upon three facts: (1) most minimum control velocities are 300 f.p.m. or less, (2) the average person walks at the rate of about 350 f.p.m., and (3) the velocity of air movement through open doors and windows on a moderately windy day is in the order of 1000 f.p.m. Hence little disturbance is required to upset the control velocity pattern at most operations

TABLE 1.—MINIMUM AIR VELOCITIES RECOMMENDED FOR THE CAPTURE OF DUSTS, FUMES, MISTS, GASES AND VAPORS RELEASED IN CERTAIN MANUFACTURING PROCESSES

Conditions of Generation of Contaminant	Recommended Minimum Velocity (Feet per Minute)	Examples of Processes
Released without noticeable air movement.....	75-100	Evaporation or escape of liquids from open vessels such as degreasing, pickling, or plating tanks; manual handling of small amounts of dry materials.
Released with low air velocity.....	100-200	Spray paint booths, cabinets and rooms; dumping dry materials into hoppers; welding.
Active generation.....	200-500	Some spray painting operations in small booths and with high pressures; active barrel filling; loading conveyors.
Released with great force..	500-2000 and higher	Grinding; abrasive blasting.

with the result that some of the contaminant will escape into the general room air. This conclusion is most important since it is not uncommon to find that open doors and windows near operations provided with local exhaust ventilation render such control measures essentially useless. The fault lies in the design of the plant layout; *operations of this nature should not be located near doors and windows.* However, with construction completed and the plant in operation, the only solution is in the education of the worker to open doors and windows judiciously. In small rooms or bays where all operations must of necessity be located

near the doors or windows, the education of the worker in the proper operation of the process and the wise regulation of doors and windows is the only solution.

To obtain the velocities cited in Table 1, it is necessary to know what quantity of air must be exhausted through the hood. Here again the individual circumstances must be taken into consideration, but very frequently the following equations will suffice for the four major types of hood.

- (1) *An unrestricted hood* at a short distance from the source of contamination.⁵

$$Q = V (10x^2 + A)$$

where Q = quantity of air to be exhausted in cubic feet per minute,

V = recommended minimum control velocity in feet per minute

(selected from Table 1),

x = distance in feet from face of hood to source of contamination,

and,

A = area of hood opening in square feet.

This equation is accurate only for unobstructed flow into an open hood. If the hood lies on a flat surface of large dimensions so that air flow is cut off from one side of the hood, the value of Q may be decreased as much as one-third for unusually favorable conditions; whereas, if there is an obstruction or some other interference between the hood opening and the source of contamination, the value of Q must be increased accordingly.

- (2) *A hood which partially or wholly encloses* the source of contamination.⁶

$$Q = VA$$

where Q, V and A are the same as above except that A is the total area of all openings in the enclosing hood.

- (3) *Canopy hoods* located above tanks or tables.⁶

$$Q = 1.4 VPD$$

where Q and V are the same as above,

P = the perimeter of the hood in feet, and,

D = the distance in feet from the hood face to the table or tank top.

- (4) *Slot type hoods* located along the upper edges of tanks.

(a) Pickling and electroplating tanks.^{7, 8}

$$Q = 120 LW$$

(b) Degreasing tanks.

$$Q = 50 LW$$

where Q is the same as above,

L = the length of the tank in feet, and,

W = the width of the tank in feet.

It should be borne in mind at all times that the quantity of air removed by a local exhaust system from a room or building must be permitted to enter the building at some appropriate point or points. This is sometimes overlooked with the result that a negative pressure exists in the building or room and the exhaust ventilation control measures do not operate satisfactorily.

2. *Air Ducts*.—The air ducts or piping serve to connect the various hoods to the collector and exhauster, and thus convey the contaminated air from the hoods to the collector or to the outside. The ductwork is usually constructed of light gage sheet steel, either unpainted, black, stainless, or galvanized. For some corrosive gases or abrasive dusts, the ducts should be lined with special protective coatings such as asphaltum, or special alloy sheets should be used. The thickness of the material employed in ductwork of different sizes is usually as follows:

<i>Diameter (Inches)</i>	<i>Gage</i>
8 and less	24
8.1 to 18	22
18.1 to 30	20
Over 30	18

Square or rectangular ductwork should be made of material about two gages heavier than round ducts of corresponding sizes.

The *duct size* for the various branches and main lines is governed by the amount of air which must be moved to collect the contaminant effectively as given previously, and the velocity necessary to convey the contaminant which is being removed. The recommended minimum conveying velocities vary from as little as 2000 f.p.m. for vapors, gases, light fumes, and very light dusts to as high as 5000 f.p.m. or more for large particles of heavy materials, such as lead dust, or the large stone dust produced by some operations.⁹

While any piping system can be made to work after a fashion with suitable dampers and a very powerful exhauster, such a system is not economical to install nor to operate. If the system is to be effective and at the same time economical, it is necessary that it be designed completely by a capable engineer. Blast gates or dampers are to be avoided, if possible, because they get out of adjustment very readily and unbalance the entire system. Excessive velocities in the various ducts are to be avoided also because the power consumption increases out of proportion to the velocity increase. To avoid deposition of the solid materials being con-

veyed, to avoid unnecessary abrasion, and to keep power consumption low, it is essential that all connecting fittings such as branch connections to main ducts, duct to collector, duct to fan, and branch pipe to hood be streamlined. This will serve to reduce the turbulence and shock losses common to poorly designed exhaust systems.

The contaminated air should be discharged to the outside and not recirculated except in very rare instances. The discharge stacks should be located at a point which will prevent the contaminated air from reentering any occupied buildings. Where the heat loss is a serious consideration owing to the large amount of air removed from the building in cold climates, some air may be recirculated if the contaminant is removed effectively from the return air by a suitable collector. The efficiency of the collector should be checked routinely to guard against a breakdown which would permit abnormal amounts of contaminant to be returned to the building.

3. *Collector*.—Not all local exhaust ventilation systems require collectors. They are used in those instances where the collected material is valuable, abrasive, corrosive, or where the unfiltered air would produce a nuisance or health hazard in the surrounding community.

Some of the types of collectors commonly employed are settling chambers, cyclones, cloth filters, oil and water air-washers, electrostatic precipitators, centrifugal separators, and fan-type collectors.¹⁰ The selection of the proper collector depends upon many considerations, of which the following are most important: (1) type of contaminant, that is, whether dust, gas, or mist; (2) efficiency of collection required; (3) cost of operation and maintenance; (4) cost of installation; (5) amount of recirculation, if any; and (6) nature of contaminant, that is, whether corrosive gas, explosive dust or other type of substance.

4. *Exhauster*.—The fan or exhauster serves to move the air through the hoods, ductwork, and collector. In addition to fans, air-, steam-, or water-operated ejectors are employed on some local exhaust ventilation systems, particularly in the explosives manufacturing industries. For low velocity exhaust systems, propeller-type fans are satisfactory, while for the more common high resistance systems, centrifugal-type fans are required. The trend at present is toward the low velocity systems wherever feasible.

In the selection of the best type and model of *exhauster*, the

following items must be considered in addition to any special items presented by the nature of the system: (1) type of contaminant to be handled, that is, whether corrosive, abrasive, or explosive; (2) resistance of the system; (3) volume of air to be handled; (4) whether or not collector is to be used in the system; (5) cost of operation and maintenance; (6) cost of installation; and (7) whether in operation 24 hours a day, one eight-hour shift per day, or intermittently.

It is advisable in all cases to locate the exhauster downstream of the collector, particularly if abrasive dust, explosive dust, or corrosive gases are handled.

Wet Methods.—The use of water or other suitable liquid at operations producing dust or fumes, or both, will generally allay the particulate matter satisfactorily. However, this method of control is necessarily limited to a small number of different operations such as grinding, drilling, and sweeping. Also the method has one inherent weakness in that the particulate matter may not be wetted successfully or that it may be readily redispersed into the atmosphere as the collecting liquid dries. When used properly, however, it is a very practical method of control and produces worthwhile results.

Good Housekeeping.—Dust and other particulate matter in the air of industries is settling out continuously at a rate dependent upon the physical characteristics of the material and the air currents. As a result, the dusts or fumes are depositing constantly on the floor; ledges; stationary machinery; workers' arms, faces, and clothing; and other objects. Vibration, shock, or unusual air currents will tend to dislodge and redisperse some of this material into the air, thereby increasing the workers' exposure needlessly. Also the skin contact of the workers is increased. All of this may be avoided by good housekeeping. The floors, ledges, overhead structures, stationary machines, and other objects should be cleaned frequently and routinely. This should be done by means of suitable vacuum systems. Blowing the dust off of machines and ledges is taboo since it is merely redispersed into the air; in other words, the atmospheric concentration is increased since more dust is kept in the air than if it were permitted to settle out. Dry sweeping also is not recommended; it should be done wet. As a general rule, *more good can be accomplished per dollar invested by good housekeeping than by any other single method.*

General or Dilution Ventilation

The object of general or dilution ventilation is to dilute the contaminated air of a workroom with a sufficient quantity of clean air to reduce the atmospheric concentration of the contaminant to a safe value. There is a certain amount of dilution taking place at all times in nearly all places. The air movement or ventilation may be natural as through open doors, windows, roof stacks, and chimneys, or it may be artificial or mechanical, if produced by fans or ejectors.

Dilution ventilation as a rule provides adequate control only if the degree of air contamination is not excessive, and particularly if the contaminant is released at a substantial distance from the breathing zone so that the contaminated air can be diluted satisfactorily before it is inhaled. For specific operations and particularly if the operator is stationed nearby, local exhaust ventilation is more practical and dilution ventilation should not be used.

The *amount of clean air* which must be supplied in a given area for suitable dilution of the contaminated air is determined by the following equation:¹¹

$$Q = \frac{X}{m}$$

where Q = the rate of ventilation in cubic feet per minute,

X = the quantity of toxic substance released in cubic feet per minute, and,

m = the maximum allowable concentration of the contaminant per cubic foot of air.

This equation assumes that the contaminated air is diluted completely before it enters the respiratory zone of any worker. Where workers are close to the source of contamination, the rate must be increased considerably, and the clean air should be supplied near the source of contamination.

For evaporating liquids the value of X in the above equation may be obtained directly from the volume of the liquid evaporated since one gram molecular weight of the vapor occupies approximately 0.8 cubic foot at normal temperature and pressure.

Even though dilution ventilation is limited in scope, as indicated above, much may be accomplished by the judicious use of doors, windows, chimneys, roof stacks, roof ventilators, fans, and ejectors. Where mechanical means are employed to obtain dilution ventilation, the following factors should be borne in mind: (1) location of air mover with respect to workers and

source of contamination, (2) natural drafts, (3) convection currents, (4) temperature of entering air, and (5) specific gravity of contaminant.

Isolation

In many instances, those operations or machines which liberate large amounts of contaminants require the immediate attention of only a few workers. Because of lack of foresight in the plant layout, however, large groups of workers are frequently located in proximity to these operations. A practical and very satisfactory method of controlling hazards of this nature is to isolate the offending operations or machines, thereby limiting the exposure to a few workers who may be protected by suitable respirators, if necessary. This method is particularly useful in those instances where the process does not lend itself readily to one of the other measures of control.

Substitution

The substitution of a nontoxic for a highly toxic material is one of the most effective methods of controlling the atmospheric health hazard. This method is, however, very limited in application. Examples of its application are the substitution of steel shot for silica sand in abrasive blasting, and the replacement of the very toxic benzene in the solvent industry with the less toxic toluol or the petroleum naphthas. Sometimes the substitution of a less toxic material results in an inferior product or in a fire or explosion hazard. In such instances, one of the other methods of control should be employed rather than substitution.

Respiratory Protective Devices

While practically all operations may be controlled by one of the foregoing methods, it is not infrequent that the cost of control by one of these methods is not justified, particularly if the exposure is intermittent and limited to a small number of workers. In such cases, the workers may be protected by wearing appropriate respirators.

The respirators commonly used as routine measures in industry may be divided into two major classifications: (1) air-purifying respirators, and (2) supplied-air respirators.¹² See Table 2 for respirator classification.

In no instance should respirators be employed as a substitute for other more satisfactory methods of control of air contamina-

TABLE 2.—RESPIRATOR CLASSIFICATION

Respirator	General Design Features	Protection Provided
I. Air-Purifying Respirators	Filter (chemical or mechanical, for removing contaminant or contaminants from inhaled air) and face-piece attached to filter directly or by means of short length of flexible rubber tubing. Entire device is carried by the wearer.	Against specific contaminants or types of contaminants. No protection against atmospheres deficient in oxygen.
A. Chemical-Filter Respirators.....	Canisters or cartridges containing suitable chemicals attached directly or by means of short length of rubber tubing to full face piece or half mask.	Against gaseous contaminants.
1. Gas Mask.....	Canisters with chemicals for individual gases or combinations thereof.	Up to 3% ammonia and 2% most other gases and/or vapors.
2. Chemical - Cartridge respirators.	Cartridges with chemicals for individual gases or combinations thereof.	Against very low or nuisance concentration of gases and/or vapors.
B. Mechanical - Filter Respirators (commonly called dust respirators).....	Fibrous filter attached to half mask face piece directly or by means of a short length of flexible rubber tubing	Against particulate contaminants.
1. Dust.....	Do.	Against dusts of all kinds.
2. Fume.....	Do.	Against fumes of various metals. Since fumes are probably more difficult to remove by mechanical filtration than other kinds of particulate matter with the possible exception of smokes, this respirator will protect against such particulate matter as dusts and mists.

TABLE 2—Continued

Respirator	General Design Features	Protection Provided
3. Mist.....	Fibrous filter attached to half mask face piece directly or by means of a short length of flexible rubber tubing.	Against mists as produced by spray-coating with paint and vitreous enamels, chromic acid mist as produced in chromium plating, and mists of other materials whose liquid vehicle does not produce harmful gases or vapors.
C. Chemical and Mechanical-Filter Respirator	Chemical and mechanical filter attached to face piece directly or by means of a short length of flexible rubber tubing.	Against combinations of gaseous and particulate contaminants.
II. Supplied-Air Respirators.		
A. Hose Mask with Blower.....	Blower (Manual or Power - operated), large diameter hose, harness, and face piece.	Against any atmosphere.
B. Hose Mask without Blower.....	Large diameter hose, harness, and face piece.	Against any atmosphere, but should not be used in immediately harmful atmosphere.
C. Air-Line Respirators..	Air supplied from special system or compressed air line to wearer through small diameter high pressure hose, reducing valve, short piece of flexible rubber tubing and face piece.	Do.
D. Abrasive Blasting....	Features same as 1, 2, 3 above (3 is more common) but in addition this device has suitable hood to protect wearer against rebounding abrasive.	Same as 1, 2, or 3 above, depending upon features but in addition has protection against impact and abrasion from rebounding abrasive material.

tion. They are used effectively, however, on jobs such as abrasive blasting, paint chipping, handling used storage battery plates,

cadmium oxide manufacture, welding operations, spraying of paints and glazes, the manufacture and use of pigments and dyes, and the like. Their most important use is under conditions where protection is required intermittently as in cleaning out operations; sweeping; after blasting; in removing cores from large foundry castings; shoveling, screening, and handling of materials; and the operation and maintenance of processing equipment.

It is the duty of management to decide whether respirators are needed. In no instance should they be selected as the control measure merely because they cost less than the other appropriate control systems. However, they may be used as a temporary expedient until the more satisfactory control measures have been placed in operation. If, after all the pertinent factors have been considered, it is concluded that respirators are needed, good respirators of the proper type should be purchased; they should be given to the workers with adequate instruction as regards the need for and proper wearing thereof, and a satisfactory system of maintenance should be set up.

The *selection* of the proper respirator is not an easy task. Some of the important factors which must be considered are: (1) nature of contaminant, that is, whether particulate or gaseous; (2) concentration of contaminant; (3) area of operation of wearer; (4) percentage of time respirator must be worn; (5) possible interference with operation, and (6) other protective devices needed by the wearer such as goggles, shields, or hoods. Table 2 will help in the selection of the appropriate device for a given operation.

Respirators, with the exception of the chemical cartridge type, are approved by the U. S. Bureau of Mines if they pass approval schedules formulated by that agency.¹³ A large variety of approved respirators is available today, and only respirators which bear this approval label should be used. Lists of approved respirators are available from the U. S. Bureau of Mines, Department of the Interior, Washington, D. C.

Maintenance, Housekeeping, and the Education of the Worker

Even though these three items are discussed individually in this section, they are interdependent. It is impossible to have good maintenance unless the housekeeping is good and the worker has been informed of the need for the control measures and the proper operation thereof. Any attempt to maintain working

equipment in good condition and to keep the work place in good order, is doomed to failure unless the worker is given the necessary instruction.

Maintenance.—It is not enough to purchase and install good, carefully designed equipment. Even the best equipment will become ineffective in a relatively short time unless it is maintained in good working condition. Maintenance is a duty of management and the worker. It is the duty of the worker to handle the equipment as intended, to keep it as clean as the nature of the operation will permit, to report to the management all signs of wear or failure and in very small industries to lubricate the moving parts. It is the duty of the management to provide the necessary personnel or instruct the proper personnel to inspect, lubricate, clean out, and repair the equipment routinely. Improper maintenance is evidenced by such indications as badly dented or collapsed hoods or ductwork; torn bags in bag-type collectors; ducts clogged with waste of all kinds, paper, or articles of clothing; collectors not functioning because they are not cleaned; dirty respirator filters; exhalation valves or filters missing from respirators; holes in ductwork; and ductwork badly corroded.

Much equipment such as the component parts of exhaust ventilation systems is expensive and an honest effort is usually made to maintain it in good condition to avoid the need for frequent replacements. However, respirators are relatively inexpensive and it is not unusual to find such equipment in use day in and day out without any provision for the maintenance thereof. Little good will be accomplished by the purchase of good respirators unless a satisfactory system is devised for their maintenance. These devices, even though rugged in construction, require daily inspection and cleaning if they are to function effectively.

The *most satisfactory method* of maintaining respirators in good condition is briefly as follows:¹⁴ (1) mark each worker's respirator with his employment number; (2) collect all used respirators at the end of each shift; (3) distribute the cleaned devices at the beginning of each shift; and (4) assign one employee, either part-time or full-time, if necessary, to the careful cleaning, sterilizing, and repairing of all respirators. The fact that each worker always gets his own respirator in a clean well-kept condition will go a long way toward overcoming the objections usually presented by workers against wearing such devices.

Housekeeping.—As used here, the term "housekeeping" refers principally to the general cleanliness and orderliness of the plant,

equipment, and machinery. Housekeeping is helped greatly by careful attention to details in the design of the plant so that the equipment and machinery are located in a methodical and systematic manner. In operating plants, housekeeping is a responsibility of the management and worker. It is the responsibility of the management to provide the requisites for good housekeeping, and it is the duty of the worker to use the facilities provided to the best advantage. Some of the *items* which are *essential* to good housekeeping are: (1) covers for containers; (2) vacuum cleaners, brooms, or hoses for cleaning; (3) shelves or compartments for storage of equipment or materials when not in use; (4) lockers for clothing; (5) toilets and wash rooms for personal hygiene; (6) trash and garbage receptacles—and they should be emptied frequently and cleaned routinely; (7) cuspidors, preferably of the disposable type, for workers who use chewing tobacco; and (8) barriers, guards, or baffles to prevent flying materials such as cutting oils, from getting on the floor and other equipment. Having a suitable place for everything and keeping everything in its proper place will go a long way toward keeping the general atmospheric contamination at a minimum.

Education of the Worker.—The education of the worker comprises two distinct subjects: (1) why something should be done, and (2) how it should be done. Such information is essential to the proper accomplishment of the workers' regular duties as well as to the proper operation and use of the various control devices. A worker cannot be expected to wear his respirator or goggles, or to turn on an exhaust blower, or open a damper unless he knows why he is doing it. Consequently, his education is of utmost importance and cannot as a rule be left entirely to the foreman. Frequent safety meetings and other meetings are necessary for the education of the worker in the proper use of his various safety and health equipment. Only by incessant instruction will the task of educating the worker be accomplished successfully.

SPECIFIC CONTROL MEASURES BY OPERATION

The present emergency has resulted in the introduction of many new operations and processes into industry and in the tremendous expansion of many operations and processes which were formerly done on a small scale. Consequently, new or increased health hazards are being constantly encountered.

While it is impossible to cover all of the new problems, there is presented herein in alphabetical order a number of new haz-

ards by operation and recommended control measures for the safe performance of these operations. In certain instances, it is desirable to refer to the chapter on *Occupational Dermatoses*.

Any material potentially toxic should be treated as though it were toxic until it has been shown to be otherwise.

All maximum allowable concentrations given in the following discussions are based on an average eight-hour daily exposure unless otherwise stated.

Abrasive Cleaning

Abrasive cleaning or abrasive blasting may be carried out with sand or steel shot as the abrasive. The health hazard associated with steel shot blasting operations is much less severe than with sand blasting operations; consequently steel shot should be used wherever possible. However, if steel shot is not available or results in an inferior product, sand should be used and can be used safely if the necessary precautions are observed, as given below:

Sandblasting.—The potential health hazard in sandblasting operations is dust of a high free silica content. The maximum allowable concentration of free silica (SiO_2) is five million particles per cubic foot of air (m.p.p.c.f.), as determined by the standard light field technique.

The dust hazard in sandblasting operations may be controlled by the following methods: (1) the use of properly designed mechanically exhaust-ventilated machines, cabinets, or rooms; (2) the use of personal protective devices; and (3) good house-keeping.

As a rule, *production abrasive cleaning operations* can be carried out in mechanical devices such as enclosed tumbling barrels, and rotary tables which are provided with adequate local exhaust ventilation. Wherever possible, devices of this nature should be used and should be maintained in good working condition so that their dust control effectiveness is not impaired. The amount of air which must be exhausted from the various types of automatic abrasive cleaning devices varies tremendously, depending upon a multitude of factors. In no instance, however, should the quantity of air exhausted be less than that required to produce a velocity of about 500 to 1000 f.p.m. at all openings from which dust might escape.

Abrasive cleaning which requires *manual operation* may be carried out in small mechanically exhaust-ventilated cabinets

which enclose the operation entirely with the exception of several holes in one wall to accommodate the hands and arms of the operator. Where possible, these access openings should be sealed with suitable flexible washers through which the hands may be inserted and which permit free movement of the arms for the operation. The precautions regarding maintenance and ventilation rate given in the previous paragraph apply for these devices also.

Large objects should be cleaned in suitable rooms or chambers which are provided with mechanical exhaust ventilation to prevent the dust from entering the surrounding atmosphere. These operations are usually conducted manually and the operator should be protected by means of a *supplied-air respirator (abrasive blasting helmet)* approved by the U. S. Bureau of Mines. The precautions concerning maintenance and the ventilation rate cited in the foregoing paragraphs should be observed for abrasive blasting rooms also.

It is usually economical to collect the abrasive sand from the dust collecting system for reuse. Whether or not this is done, the dust should be collected from the exhausted air before it is discharged to the outside and the discharge outlet should be located at a point which will prevent the reentrance of the contaminated air into the buildings. In no instance should the filtered air be recirculated into the building. The discharge of the dust collector hopper should be provided with a dust-tight flexible sleeve which is attached to the top, or extends to the bottom, of the receptacle for the collected material to prevent the escape of dust when the collector hopper is emptied.

Good housekeeping which includes such items as keeping the floor, ledges, and machinery free of sand and dust; emptying the collector hoppers frequently and routinely; maintaining all connections through which dust or dust-laden air are conveyed in a dust-tight condition; and cleaning, sterilizing, and repairing the personal protective devices daily will aid considerably in keeping the dust concentration in the inspired air at a safe level.

Shotblasting.—The potential health hazards in shotblasting operations are metallic dusts and silica dusts in those instances where objects having sand on their surfaces are cleaned. The maximum permissible safe concentration for some metallic dusts is fifty million particles per cubic foot of air; for free silica dust, five million particles, as determined by the standard light field

technique; and for lead dust, 0.15 milligrams per cubic meter of air (mg./m.^3).

Even though the health hazard with shotblasting as a rule is much less severe than with sandblasting, the same general control measures are applicable. However, the various precautions need not be observed as rigidly as is the case with sandblasting.

Acid Pickling (see Pickling)

Acid (Nitric) Tank Filling

The potential health hazard associated with nitric acid tank filling is *oxides of nitrogen*. The currently accepted maximum allowable concentration of nitrogen oxides for an eight-hour daily exposure is 25 parts per million (p.p.m.).

In storage tanks where oxides of nitrogen are discharged while the tanks are being filled, the vents should be connected to an acid recovery plant or extended to a sufficient height to prevent injury to the workers through contact with the concentrated nitrogen oxides. Where necessary, the oxides of nitrogen should be removed from the exhausted air by means of a suitable wet collector.

Airplane Motor Cleaning

The operation of spraying airplane motors with gasoline to clean them after they have been tested presents a potentially serious exposure to gasoline vapor, and sometimes to lead. The maximum allowable concentration for gasoline vapor is 1000 p.p.m. and for lead is 0.15 mg./m.^3 . In addition, if leaded gasoline is used, the lead tetra-ethyl is absorbed readily through the skin.

Gasoline containing lead tetra-ethyl should never be used for this purpose. The spray cleaning operation should be carried out in a booth, cabinet, or small room provided with mechanical exhaust ventilation at the minimum rate of 150 c.f.m. per square foot of booth opening or room cross-sectional area. In addition, the worker should always remain upstream of the motor, that is, in the clean air.

Alkali Cleaning

The potential health hazards associated with cleaning parts in an alkali bath are high relative humidities and skin contact with the alkali.

Rooms in which alkali cleaning tanks are located should be provided with general mechanical ventilation with sufficient air removal to keep the relative humidity from attaining a value which would result in very uncomfortable working conditions.

The operator should wear protective clothing to prevent skin contact with the alkali.

Alumiliting (Finishing Aluminum and Aluminum Alloy Products)

The health hazard in this operation is from exposure to the sulfuric acid gases and mists liberated from the acid dipping tanks. While the maximum allowable concentration for sulfuric acid in the air has not been determined definitely, it is believed to be the same as for hydrochloric acid gas, namely, 10 p.p.m.

The hazard may be controlled by the use of slot-type lateral exhaust hoods along one or both long sides of the dipping tank and exhausting a minimum of 120 c.f.m. of air per square foot of tank area through the hoods.

Amatol Break-Up

The potential health hazard from breaking up solid amatol is the TNT in the amatol dust. The maximum allowable safe concentration for atmospheric TNT is 1.5 mg./m.³.

All amatol or TNT break-up operations should be carried out in an exhaust-ventilated booth with the worker upstream of the operation. The recommended minimum ventilation rate for such booths is 300 c.f.m. per square foot of booth opening.

If the operation is an intermittent one, and particularly if no adequately ventilated booth is available, the work may be done in an isolated location or on the outside so that the dust is not contributed to the air of a room occupied by other workers. The operator will receive adequate protection if he wears a U. S. Bureau of Mines approved mechanical filter respirator.

Amatol Bucket Cleaning (Steam Out)

The potential health hazard associated with amatol bucket cleaning is TNT vapors and fumes. The currently accepted maximum allowable atmospheric concentration for TNT fumes and vapors is 1.5 mg./m.³.

The water baths used to melt the TNT encrusted in the buckets should be enclosed as much as possible and provided with

a mechanical exhaust ventilation system adequate to give a minimum velocity of 100 f.p.m. across all face openings.

Amatol Cooling (Open Tubs) (see also TNT Cooling)

The potential health hazard associated with amatol cooling is TNT vapors and fumes. The currently accepted maximum allowable atmospheric concentration of TNT vapor and fumes for an eight-hour daily exposure is 1.5 mg./m.³.

This operation should be isolated in an area having good natural ventilation. Covers should be provided for the cooling kettles and all stirring should be done mechanically.

Amatol Pouring and Puddling

The principal potential health hazard associated with amatol pouring is TNT vapors and fumes. The currently accepted maximum allowable atmospheric concentration of TNT for an eight-hour daily exposure is 1.5 mg./m.³.

If this operation is carried out in well ventilated bays or rooms, no health hazard will exist under normal operating conditions. Good ventilation may be obtained by keeping all doors and windows open as much as possible and by supplying or removing an adequate quantity of air by mechanical means. The exact amount of air which must be handled depends upon several conditions and must be determined for each plant.

Frequently several dust-producing operations, such as riser break-out, amatol break-up, and tub cleaning, are conducted in the pouring bays. This contamination in addition to that contributed by the pouring and puddling operations produces a concentration in excess of the safe limit. Therefore such operations should not be done in the pouring bays. Also all workers in these bays should be rotated from job to job.

If the atmospheric TNT concentration is found to exceed the allowable limit, general ventilation should be improved; local exhaust ventilation should be provided at the major sources of air contamination; and for intermittent exposures, respirators approved by the U. S. Bureau of Mines for toxic dusts should be used.

Amatol Preparation

The potential health hazards associated with amatol preparation are TNT vapors and fumes and ammonium nitrate dust. The currently accepted maximum allowable atmospheric concentration of TNT vapor and fumes for an eight-hour daily exposure

is 1.5 mg./m.³. While ammonium nitrate dust is not considered highly toxic, all reasonable means should be used to keep the atmospheric concentration of this dust low in accordance with good engineering practice.

The mixing kettles should be enclosed and provided with local exhaust ventilation adequate to maintain a minimum face velocity of 100 f.p.m. when the doors of the kettles are open. Due precautions must be observed as regards the safety hazard associated with the collection of explosive dusts in the exhaust ventilation system. A chemical-cartridge respirator for organic vapors should be worn by the operator when he has his head in or near the kettle for cleaning operations.

Ammonia Oxidation (Nitric Acid Manufacture)

The potential health hazards in ammonia oxidation are ammonia and oxides of nitrogen. The maximum permissible safe concentration for ammonia is 100 p.p.m. for an eight-hour daily exposure; and for the oxides of nitrogen it is 25 p.p.m.

Leaks in and about the pump in the pump house are usually a source of constant atmospheric pollution with ammonia. Since the process is automatic and normally requires little attention, the exposure should not be serious if the workers are able to breathe without undue irritation for the short and infrequent periods of exposure. If the concentrations are sufficiently high to cause objectionable irritation, U. S. Bureau of Mines approved gas masks for ammonia should be worn as an emergency measure.

Ammoniacal gas should not be allowed to concentrate near the catalyst in the compressor house. If necessary, suitable local mechanical exhaust ventilation should be installed to keep the atmospheric ammonia concentration below 100 p.p.m.

The vent stacks from the compressors should be made sufficiently high to prevent the nitrogen oxides from contaminating the workroom atmosphere of the compressor house, surrounding buildings, and work area. If it is not practicable to prevent contamination by raising the stacks to a sufficient height, the effluent gases should be collected in a suitable wet collector.

Aniline Distillation

The potential health hazard associated with aniline distillation is aniline vapor. The currently accepted maximum allowable atmospheric concentration of aniline for an eight-hour daily exposure is 5 p.p.m.

Even though this is an enclosed process, in normal operating conditions, small amounts of aniline are liberated in the general room air. The atmospheric concentration of aniline may be kept below the toxic limit by means of roof ventilators equipped with mechanically driven fans and by keeping all doors and windows open as much as possible. The vents from the aniline water storage tanks should be extended outside the building to a point where the vapors will not reenter the building.

Since aniline is readily absorbed through the skin, direct skin contact should be avoided. Good personal and general cleanliness should be practiced by the workers.

Aniline Manufacture (Nitrobenzene Reduction)

The principal health hazards associated with the reduction of nitrobenzene are aniline vapor and nitrobenzene vapor. The currently accepted maximum allowable atmospheric concentration of each of the above substances for an eight-hour daily exposure is 5 p.p.m.

Since this is an enclosed process, only small amounts of these substances are liberated to the general room atmosphere under normal operating conditions. The atmospheric concentrations of these substances may be kept below their toxic limits by means of roof ventilators equipped with mechanically driven fans and by keeping the doors and windows open as much as possible.

These substances are readily absorbed through the skin. Therefore the necessary precautions should be taken to avoid skin contact with them. In addition, strict personal hygiene and general cleanliness should be enforced by the proper supervisory personnel.

Anodizing (see Electroplating)

Ballistics Testing

In ballistics testing the potential health hazards to the riflemen are oxides of nitrogen, carbon monoxide, lead, and silica dust, and to the observers at the butt ends of the range, lead and possibly silica dust.

The maximum allowable concentrations of these dusts and gases in the atmosphere for an eight-hour daily exposure are:

Oxides of nitrogen	25 p.p.m.
Carbon monoxide	100 p.p.m.
Silica (sand)	5 m.p.p.c.f.
Lead	0.15 mg./m. ³

To prevent atmospheric concentrations in excess of those given above, mechanical ventilation is necessary.

Penetration Ranges.—If the observer does not enter the range directly after test-firing ceases, the lead hazard at the target end of the range may be controlled by exhausting air at or near the target end at a minimum rate of 200 c.f.m. per square foot of cross-sectional area of the range. On the other hand, if the observer enters directly after the test-firing ceases, higher ventilation rates are necessary. Where conditions permit, this same ventilation will serve to control the riflemen's exposure if the air inlet is located at the firing end of the range. Otherwise, a separate exhaustor will be necessary for the firing room, in which case the air should be admitted at the center or toward the target end of the range. The supplied air should be heated, if necessary. Propeller-type fans will serve as exhaustors if the ductwork is kept at a minimum; otherwise, centrifugal fans will be needed.

Good housekeeping, particularly keeping the walls and floor of the ranges free of dust, will aid considerably in controlling the lead hazard. Daily sweeping or preferably washing with hose and water is suggested.

Velocity Ranges.—Same as *Penetration Ranges* except that lead hazard may be nil.

Function and Casualty, and Hangfire Ranges.—In these tests the rifleman may be exposed to lead and silica as well as to oxides of nitrogen and carbon monoxide. The interposition of a reasonably large room between the muzzle port and the sand butt, requiring the bullet to pass through a wall with a second port before entering the room containing the sand butt, will keep the agitated dust from being blown back to the rifleman. Both the intermediate room and the room containing the sand butt should be mechanically exhaust-ventilated at a rate sufficient to control the hazard. A minimum of 1000 c.f.m. per range is suggested, but greater quantities must be exhausted in some cases, particularly if several rifles are fired simultaneously into the same range.

If considerable sand is contained in the exhausted air, a collector should be included in the exhaust ventilation system to prevent a nuisance in the nearby areas and to reduce the abrasive action on the fan. The collector should be located upstream of the fan. The discharge stack should be so located that the contaminated air will not reenter occupied buildings.

Balloon Manufacture (see also Rubber Goods Fabrication)

The potential health hazards in the cementing operations in the manufacture of barrage balloons result from the exposure to the cement solvents. The solvents vary as indicated in the section under "Rubber Goods Fabrication" and the health hazards vary accordingly.

The health hazard may be controlled by (1) employing cements containing the less toxic solvents and (2) conducting as much as possible of the cementing on tables with local exhaust ventilation. About 75 per cent of the cementing operations can be performed on tables, leaving only 25 per cent to be done on the floor where adequate control is more difficult. The cementing tables should be provided with slot-type exhaust hoods along both long sides of the table top. The exhaust ventilation rate should be sufficient to maintain the workers' exposure below the maximum allowable concentration for these solvents being used. To accomplish this, an air removal rate of about 50 c.f.m. per square foot of table top is suggested. The exposure for the floor cementing operations may be controlled by providing good general ventilation (about 10 air changes per hour) and by exercising care to keep the cement and solvent containers closed as much as possible and to use only as much solvent as is necessary to soften the fabric surface.

The inspection and final seaming inside the balloon presents a health hazard which should be controlled by general ventilation (air change) in the balloon at the rate given by the following equation $Q = \frac{X}{m}$, which is explained in the earlier part of this chapter.

Barrage Balloon Manufacture (see Balloon Manufacture)**Benzene Nitration**

The potential health hazards associated with the nitration of benzene are nitrobenzene and benzene vapors. The maximum allowable concentrations, on the basis of an eight-hour daily exposure, are 5 p.p.m. for nitrobenzene and 100 p.p.m. for benzene.

Since the nitration of benzene is an enclosed process, there should be no appreciable amount of benzene and nitrobenzene vapors liberated into the general room air under proper operating conditions. The small amounts of vapor which may be

liberated normally may be kept below the toxic limit by means of roof ventilators with mechanically driven fans and by keeping the doors and windows open as much as possible.

If workers repairing benzene nitrators are exposed to nitrobenzene vapors, they should wear chemical-filter respirators (gas masks) or supplied-air respirators (type B hose masks) approved by the U. S. Bureau of Mines for protection against acid gases and organic vapors.

Boat (Rubber) Manufacture (see Rubber Goods Fabrication)

Booster Cavity Drilling

The potential health hazard in booster cavity drilling is TNT dust. The currently accepted maximum allowable concentration for TNT is 1.5 mg./m.³ of air for an eight-hour daily exposure.

This operation is usually not a very dusty one and can easily be made almost dust-free by the judicious use of local exhaust ventilation. A small hood will suffice, located near the operation or attached to the drill, through which sufficient air is exhausted to remove all the fine dust. The suggested ventilation rate is such that the velocity at the source of dust production is 200 f.p.m. Consideration should be given to the possible collection of the TNT dust in the exhaust line; to the collection of this dust from the exhausted air; and to the disposition of the collected TNT.

Booster Cup or Tube Loading

The potential health hazard in loading booster cups and tubes with tetryl pellets is tetryl dust. The concentration of tetryl dust in the atmosphere should be kept below 1.5 mg./m.³. (See *Tetryl Blending*.)

The alignment of the pellets for insertion into the tubes as well as the actual insertion of the pellets into the cups or tubes releases considerable dust to the atmosphere. This exposure may be controlled by means of appropriate exhaust ventilation.

For the usual operations, down draft ventilation through the loading and aligning trays or racks is recommended. The trays or racks need perforated or slotted bottoms and may be permanently connected with the exhaust system or may be temporarily placed on an appropriate frame on the work bench through which air is exhausted. The recommended minimum ventilation rate is 100 c.f.m. per square foot of tray or rack area or sufficient to produce a minimum removal velocity of 100 f.p.m. at

the source of dust production. A dust trap or hopper should be located below the tray or grille to catch large particles and the air borne dust should be removed by a suitable collector (preferably wet) before the air reaches the fan. The dust trap and collector should be cleaned frequently and routinely.

In lieu of the above method, the individual operations may be partially enclosed, with transparent material if necessary, and provided with exhaust ventilation. The enclosure should be open in the front to permit the worker to perform the necessary operations expeditiously. The exhaust ventilation rate should be not less than 100 c.f.m. per square foot of opening in the enclosure. Either down draft through a grille in the table top or lateral ventilation through a connection in the enclosure may be used.

Until the exposure is controlled by means of exhaust ventilation, the workers should wear U. S. Bureau of Mines approved mechanical filter respirators at all times while performing the aligning and loading operations. Clean cloth facelets should be provided on the respirator masks at least daily to prevent dermatitis where the mask touches the face.

Bullet Casting (see Lead Bullet Casting)

Camouflage Paint Manufacture

In the manufacture of some of the camouflage paints, a chlorinated phenol known as "Dowicide F" is used as a wood preservative and mildew preventive. The maximum allowable concentration for this material is not known, but it produces violent coughing and is very irritating to the throats of exposed personnel and consequently requires adequate control measures.

The operation of mixing the Dowicide F with other dry paint ingredients should be done in a completely enclosed area which is exhaust-ventilated at the rate of about five air changes per minute.

Carbide Tool Manufacture

In the manufacture of cemented carbide tools, the finishing operations (grinding to the desired shape and sawing tool tips) are very dusty. These high concentrations of fine dust seem to produce a lung involvement which is under thorough investigation at present. Pending the outcome of this investigation, the dust should be controlled at its source.

The dust may be controlled by means of local exhaust ventilation at rates suggested under *Grinding* for similar conditions. Collectors in the exhaust systems are advisable owing to the value of the material collected.

Cavity Drilling, Booster (see Booster Cavity Drilling)

Cold Tinning Process

The health hazard associated with this operation is the exposure to high concentrations of atmospheric mercury and potentially to high concentrations of lead. The maximum allowable concentration for mercury is 0.10 mg./m.³ and for lead is 0.15 mg./m.³ based on an eight-hour daily exposure.

The cold tinning process may be used locally for finishing metal objects with a protective coat which will protect against rust even in the presence of steam. It is commonly used where hot tinning is impracticable and where paint will not endure. Briefly, the operation consists of (1) cleaning the metal surfaces with acid, (2) applying a bonding or adhesive coat of mercury amalgam (usually by manual rubbing with a compound containing mercury and compounds thereof), and (3) applying a protective coat of about half and half lead and tin by means of a metallizing gun.

The lead exposure is intermittent and usually of short duration and will be controlled adequately if the same precautions are taken as are necessary for applying the bonding coat. The compound containing mercury should be applied in a segregated or enclosed space which is provided with mechanical ventilation at the minimum rate of 20 air changes per hour or 150 c.f.m. per square foot of opening into the enclosing space, whichever is the higher, and the operator should wear a U. S. Bureau of Mines approved supplied-air (air-line) respirator at all times while performing this operation.

Colloiding (Nitrocellulose and Ether Mixing and Macerating in the Manufacture of Smokeless Powder) (Mix Houses)

The potential health hazards in the colloiding operations are alcohol and ether vapors.

Although the maximum permissible safe concentrations are controversial at present, an attempt should be made to keep these concentrations as low as is feasible and it is suggested that they should never exceed a total of 1000 p.p.m.

Adequate control of the vapors liberated in colloid operations may be accomplished by the judicious use of general and local exhaust ventilation. These ventilation systems should be tied in with the solvent recovery system, if economically feasible.

Owing to the nature of these operations, it is impossible to give specific recommendations for local exhaust ventilation. Slot-type hoods are suggested, attached to or located near the multiple funnel, which fits on the receptacles into which the mixers are dumped. The hoods should be exhaust-ventilated through a flexible metal hose which might be detachable from the hood if it is an integral part of or attached to the funnel device. The flexible metal tube might be connected to the solvent recovery system or to an auxiliary system, depending upon the various conditions. The ventilation rate should be such that the air movement toward the exhaust hood is at least 100 f.p.m. in the zone of vapor liberation.

In addition, good general ventilation will be necessary. Depending upon economic considerations, this should be accomplished by means of a mechanical ventilation system which may be part of the solvent recovery system; or it may be a separate system; or it may be partly separate and partly tied in to the solvent recovery system.

Each plant must be considered separately and the appropriate measures designed accordingly.

Before scraping the mixer blades, the mixers should be allowed to remain open sufficiently long to permit the vapors to escape. The workers should wear chemical-filter respirators (gas masks) or supplied-air (air-line) respirators approved by the U. S. Bureau of Mines for organic vapors.

The "air blowing" of mixers by compressed air which blows the ether alcohol vapors into the workroom atmosphere should be discontinued. The use of a suction-type exhaust hose attached to the mechanical exhaust ventilation system or to a suitable auxiliary system should be substituted.

Cotton Picking, Drying and Weighing

The potential health hazard in the picking, drying, and weighing of cotton is that of cotton dust. The maximum permissible safe concentration for cotton dust is the same as for other nuisance dusts, namely, 50 million particles per cubic foot of air. However in some instances, it is very annoying to the exposed workers in substantially lower concentrations.

Local mechanical exhaust ventilation should be employed at the picking end and at the weighing end of the cotton drying machine. The minimum rate of air movement at the source of the dust should be 100 f.p.m. Adequate collectors should be provided for this dust to prevent a nuisance around the building on the plant grounds.

If local exhaust ventilation fails to prevent a concentration of cotton dust which is a nuisance to the workers, they should wear mechanical-filter respirators approved by the U. S. Bureau of Mines.

Crack Testing, Mercury (see Mercury Crack Testing)

Cup Loading, Booster (see Booster Cup Loading)

Decarbonizing

The health hazard in decarbonizing operations results from exposure to the solvent vapors escaping from the decarbonizing tanks. The solutions used for decarbonizing vary considerably but usually contain kerosene, creosote oil, and ethylene dichloride. Whereas the specific toxicity of some of these solvents is unknown, it is known that most of them are definitely toxic and require control measures. (The maximum allowable concentration for ethylene dichloride is believed to be about 100 p.p.m.)

The control measures are the same as given under *Degreasing*, which immediately follows.

Degreasing

Potential health hazards in solvent degreasing operations are vapors of trichlorethylene, ethylene dichloride, carbon tetrachloride, or other highly volatile solvents. The maximum allowable concentrations for an eight-hour daily exposure to vapors of trichlorethylene, ethylene dichloride, and carbon tetrachloride are 200 p.p.m., 100 p.p.m. and 100 p.p.m., respectively.

Degreasing operations should be carried out in properly designed tanks which may or may not be provided with local exhaust ventilation but should have adequate cooling or condensing capacity. The atmospheric contamination with the solvent vapors is usually low enough to present no health hazard when (1) the tanks are small (not over 10 square feet in cross-sectional area), (2) the heat input and cooling capacity of the cooling coils are carefully regulated, (3) the tanks are located

in large rooms with high ceilings and not near open doors or windows, (4) the withdrawal rate of the cleaned objects is slow (not more than 12 f.p.m.), and (5) the general room ventilation is good. However, for large tanks, or for any tanks located near open doors or windows or in small rooms, local exhaust ventilation at the tanks is necessary. The usual type of ventilation consists of slot-type lateral exhaust hoods located along one or both long sides of the tanks at the upper edge. The recommended minimum exhaust ventilation rate may be computed as follows:

$$Q = 50 LW$$

where Q = the exhaust ventilation rate in c.f.m.,
 L = the length of the tank in feet, and,
 W = the width of the tank in feet.

The exhausted air should be discharged at a point outside the building where it cannot reenter occupied buildings.

Tight-fitting covers should be employed on degreasing tanks whenever possible.

The cleaning out of degreasers, particularly those in which the workers must enter the tanks in the process, may involve exposures to excessive concentrations of solvent vapors for limited periods of time. Such exposures may be prevented by airing out the machine after withdrawal of the liquid, and by the use of supplied-air respirators (air-line respirators or hose masks) approved by the U. S. Bureau of Mines, when the exposures are severe and when their use does not impede the workers too greatly. Chemical cartridge respirators do not afford adequate protection when the exposures are severe.

If the odor of solvent persists in the vicinity of the machine, or if the workers complain of ill effects, the concentration of solvent vapors in the atmosphere should be determined to ascertain the efficiency of existing controls. The atmospheric concentration of solvent vapors should not exceed the maximum allowable concentration for the particular solvent used.

When carbon tetrachloride has been used for degreasing and it is removed from the degreased object by a centrifugal process, the carbon tetrachloride vapors should be kept from the room atmosphere by suitable means, such as enclosing the centrifuge and exhaust ventilating the enclosure at the minimum rate of 100 c.f.m. per square foot of opening in the enclosure. The opening in the enclosure obviously should not be in the line of throw of the centrifuge.

The solvent containers which are used to hold carbon tetrachloride or other solvent used in small degreasing operations, such as wiping of metal parts, should be kept closed by tight-fitting covers whenever possible.

Dimethylaniline Sulfate (DMAS) Nitration (see Nitration)

Dimethylaniline (DMA) Sulfation

The principal potential hazard in the sulfation of DMA is DMA vapor. Although no maximum allowable concentration has been established for exposure to DMA vapor, the toxicity of DMA is believed to be of the same order as that of aniline, the maximum allowable concentration of which is 5 p.p.m. It is suggested, therefore, that the atmospheric concentration of DMA be maintained below a value of 5 p.p.m. wherever practicable.

Exposure of DMA vapor should be eliminated or reduced as much as possible by enclosure of the sulfation process, and use of adequate local exhaust ventilation with discharge of all DMA vapor to the outside atmosphere. The discharge vents should be located in such a manner that reentrance of the vapors to the workroom is prevented.

Dinitrotoluene (DNT) Crushing and Screening

The potential health hazard in DNT crushing and screening operations is DNT dust. Although no maximum allowable concentration has been established for DNT in the atmosphere, the toxicity of DNT is believed to be of the same order as that of TNT; therefore, it is recommended that the concentration of DNT in the atmosphere be kept below 1.5 mg./m.³

Control of these operations should be secured by enclosing the operations, by the use of dust-tight sleeves, by the application of local exhaust ventilation, and by the use of personal respiratory protection where necessary. A program of strict personal hygiene should be observed at all times. Where possible, a gravity-type system should be used; the crushed DNT being discharged by gravity from the crusher onto the screen and, finally, the screened material falling into an enclosed receiving unit.

It is believed that complete enclosure of the operations will keep the atmospheric concentration of DNT below 1.5 mg./m.³ Local exhaust ventilation and respirators should be used only if the above method fails.

An enclosed, mechanically-operated crusher should be used. Care should be taken in filling the crusher to avoid dissemination of dust into the room atmosphere. Discharge of crushed DNT from the crusher onto the screen and from the screen into the enclosed receiving unit should be done through dust-tight sleeve connections which will prevent escape of dust into the workroom air. The receiving hopper, or other unit, located beneath the screen, should be enclosed completely and should be kept closed during the actual screening.

If the use of local mechanical exhaust ventilation is indicated by continued high concentrations of DNT in the atmosphere, consideration should be given to its application at the crusher, at the screen, and at the final receiving unit beneath the screen. The rate of air movement at the source of dust should be at least 100 f.p.m. and should be 200 or more f.p.m. at the very dusty operations. The contaminated air should be discharged to the outside atmosphere in a manner such that it cannot reenter the building.

If workers are exposed intermittently to concentrations of DNT dust in excess of 1.5 mg./m.³, they should wear mechanical-filter respirators approved by the U. S. Bureau of Mines.

Diphenylamine (DPA) Crystallization and Packing

The potential health hazards in the crystallization and packing of DPA are DPA vapors and dust. No maximum allowable concentration has been established for exposure to vapors and dust of DPA but the handling and processing of this material should be in accordance with good engineering practice.

Vapors of DPA should be removed from the crystallizers through canopy-type exhaust hoods which are located above the crystallizers and are exhausted mechanically to the outside atmosphere. The exhaust velocity in each case at the source of the vapor should be at least 100 f.p.m.

Dissemination of DPA dust into the room atmosphere should be controlled by installation of adequate side guards on the crystallizer discharge chutes, careful filling of the containers with crystalline DPA to prevent overflow, and maintenance of an effective clean-up schedule.

Electroplating

The potential health hazards associated with electroplating are chromic acid mists, metallic salts, cyanides, and other toxic

gases. The maximum allowable concentrations for some of the materials which are encountered are as follows:

Chromic acid mist	0.1 mg./m. ³
Arsenic (as arsine)	1 p.p.m.
Hydrogen cyanide	20 p.p.m.
Cadmium	0.1 mg./m. ³

If toxic gases and mists are liberated in the electroplating process, as is the case with chromium and arsenic electroplating, and some anodizing operations using dilute solutions of chromic acid and strong electric currents, local exhaust ventilation is necessary at the plating tank. A lateral exhaust slot-type ventilation system removing at least 120 c.f.m. of air per square foot of tank area is recommended. Where high current densities are used in anodizing or electroplating, much higher ventilation rates are needed to remove the air contaminant effectively. For proper functioning of the exhaust ventilation system, the level of the plating solution should be at least 4 inches below the exhaust slots.

If toxic gases and mists are produced in the plating of cadmium, copper, and zinc, the above recommended exhaust ventilation system should be used.

The electroplating of zinc, copper, and nickel from acid or neutral solutions (non-cyanide baths) does not give rise to toxic gases and mists and therefore does not require mechanical exhaust ventilation of the plating tank. However, good natural ventilation is recommended.

In those operations using a cyanide bath, care should be taken to avoid introduction of acid into the bath since hydrogen cyanide is liberated under these conditions. All cyanide baths should be conspicuously marked *poisonous*.

It is also essential that skin contact with the plating baths be prevented. Care should be exercised to prevent splashing of the plating bath.

For more detailed information on all phases of safety in electroplating, see reference 7.

For a discussion of the health hazards connected with the cleaning process prior to electroplating, see *Pickling*.

Fabric Coating (see also Rubber Goods Fabrication)

In addition to the materials mentioned under "Rubber Goods Fabrication" chlorinated paraffins, chlorinated phenols, antimony oxide, chromic oxide, and other similar materials are used in

weatherproofing, fireproofing, and mildewproofing of canvas fabrics such as tent cloth. These materials are largely dermatitis producers at room temperatures, but at elevated temperatures such as are employed in drying the fabric after it has been coated, vapors may be liberated from the chlorinated compounds.

The dermatitis may be prevented by means of suitable protective clothing and protective creams. The toxic vapors which may be liberated in the drying ovens should be removed by exhaust ventilating the ovens.

Forging

The potential health hazards associated with forging are carbon monoxide and high temperatures. The maximum allowable concentration of carbon monoxide for an eight-hour daily exposure is 100 p.p.m.

Good natural ventilation should be provided in order to avoid excessively high temperatures and this should be supplemented by mechanically-operated exhaust fans in roof ventilators.

Canopy-type hoods with large diameter stacks should be employed over the furnaces and if the atmospheric concentration of carbon monoxide exceeds 100 p.p.m., this ventilation should be improved by the use of propeller-type fans in the discharge stacks. The point of discharge should be so located that the exhausted air does not reenter any occupied buildings.

Propeller-type fans in these stacks will aid also in the maintenance of more suitable room temperatures.

Furnace (Coreless Induction) Lining Removal

The potential health hazard associated with the removal of the linings of coreless induction furnaces is silica dust. The maximum allowable concentration of free silica (SiO_2) for an eight-hour daily exposure is 5 m.p.p.c.f. of air as determined by the standard light field technique.

In removing the furnace lining, it is necessary for the worker to have his head and shoulders inside the furnace. Therefore, his exposure to dust is severe. Supplied-air (air-line) respirators approved by the U. S. Bureau of Mines should be worn for these operations, if possible.

If supplied-air respirators are impracticable, U. S. Bureau of Mines approved mechanical-filter respirators (for pneumoconiosis-producing dusts) should be worn. These respirators must be

cleaned and repaired daily if they are to give satisfactory service and protection.

Fuze Cavity Reaming (see Tetryl Reaming)

Glycerine Nitration

The potential health hazards associated with the nitration of glycerine are nitrogen oxides and nitroglycerine. The maximum allowable concentration of nitrogen oxides in the atmosphere is 25 p.p.m. Although the maximum allowable concentration for nitroglycerine is not known, it is relatively toxic and the atmospheric concentration should be kept as low as possible.

All glycerine nitrators should be completely enclosed and located in rooms having good general ventilation.

In addition to absorption by inhalation, nitroglycerine is absorbed readily through the skin. Therefore, special attention should be paid to housekeeping (cleanliness of workroom) and to personal hygiene which should include changing work clothes daily, washing hands and face thoroughly before eating, taking showers at end of shift, and wearing protective clothing such as impervious gauntlets and gloves.

Grinding

The potential health hazards associated with grinding operations are abrasive, metallic, and lead dusts. The maximum permissible safe concentrations of the abrasive and metallic dusts will vary with the chemical composition of the dust generated but should never exceed 50 m.p.p.c.f. of air as determined by the standard light field technique. The maximum allowable concentration of lead in the atmosphere is 0.15 mg./m.³

Control in grinding operations should be accomplished by the use of wet grinding, general exhaust ventilation, local exhaust ventilation, or personal respiratory protective devices.

Wet grinding operations do not require local exhaust ventilation. Good general room ventilation may be necessary if the operations are of such magnitude as to produce excessive mist and humidity.

Continuous *dry grinding operations* should be provided with local mechanical exhaust ventilation. The exhaust hoods should be so located that the dust thrown off from the grinding wheels will be in the direction of the air flow into the hood. The following exhaust duct sizes and rates of air removal are recommended :

STANDARD GRINDER HOOD

Wheel Diameter (Inches)		Wheel Width (Inches)	Diameter of Exhaust Outlet (Inches)	Volume of Air Removed through Hood at 4500 f.p.m. Duct Velocity (c.f.m.)
Minimum	Maximum			
—	9	1.5	3	221
Over 9 . . .	16	2	4	392
Over 16 . . .	19	3	4.5	497
Over 19 . . .	24	4	5	614
Over 24 . . .	30	5	6	884

For more detailed information see references 15 and 16.

Where portable grinders are used, particularly if lead coated materials or materials containing considerable lead, such as solder, are being ground, U. S. Bureau of Mines approved respirators for toxic dusts should be worn if control by means of ventilation is either inadequate or impracticable.

Heat Treating

The principal potential health hazard in heat treating operations is carbon monoxide. The maximum allowable concentration for carbon monoxide in the atmosphere is 100 p.p.m. Other potential health hazards are cyanide and acrolein in certain types of heat treating. The currently accepted maximum allowable concentration for hydrocyanic acid gas is 20 p.p.m. and for acrolein, 1 p.p.m.

Heat treating furnaces should be examined periodically for defective equipment which would permit the escape of carbon monoxide into the workroom atmosphere. Partial control of carbon monoxide may be obtained by the use of suitable hoods enclosing the furnaces as much as possible and allowing the carbon monoxide and excessive heat to be removed by convection currents. If the above control is inadequate, as shown by the presence of excessive concentrations of carbon monoxide, the exhaust ducts from the hoods should be equipped with fans to provide mechanical exhaust ventilation and thereby increase the rate of air removal sufficiently to maintain the atmospheric concentration of carbon monoxide within the maximum allowable limit.

The excessive room temperatures which are commonly met in heat treating workrooms should be reduced by the use of natural ventilation where possible and by the use of roof ventilators equipped with mechanically operated exhaust fans.

Cyanide heat treating units should be controlled by the use of measures similar to those listed above.

The use of oil quenching baths in connection with heat treating operations presents possible hazards from acrolein, if vegetable oil is present in the quenching oil, and from carbon monoxide. The possibility of exposure to carbon monoxide is reduced by avoiding operation of oil quenching baths at excessively high temperatures, that is, by controlling the temperature of the substance to be quenched. The use of mineral oil as a quenching material eliminates the possibility of exposure to acrolein.

Igniter Mixture Preparation

The potential health hazard in the preparation of igniter mix is dust composed of igniter mix components. Even though the specific toxicity of these dusts is not known, it is believed that the total amount of dust in the atmosphere should not exceed 5.0 mg./m.³ and for barium peroxide the value should not exceed 0.5 mg./m.³

The exposure time at these operations is short and intermittent and adequate protection may be obtained through the use of mechanical-filter respirators approved by the U. S. Bureau of Mines.

Incendiary Mixture Preparation

The potential health hazard in the preparation of incendiary mixture is carbon tetrachloride. The maximum allowable concentration of carbon tetrachloride is 100 p.p.m. for an eight-hour daily exposure.

All contaminated air from the blender discharge and the granulation of the blended material should be removed by adequate local exhaust systems and discharged to the outside atmosphere. No recirculation of air contaminated with carbon tetrachloride should be permitted.

Lead Bullet Casting

The potential health hazard associated with the operation of casting lead bullets is atmospheric lead. The maximum allowable concentration of lead in the air is 0.15 mg./m.³ based on an eight-hour daily exposure.

Partial enclosure of the operations and exhaust ventilation of the enclosure or local exhaust hoods near the source of contamination serve to control this exposure adequately. The ventila-

tion rate should be such that the air velocity into the openings of the enclosure is not less than 100 f.p.m. and for local exhaust hoods it should be adequate to produce an air velocity in the proper direction at the source of contamination of at least 100 f.p.m.

Lead Burning

The principal potential health hazard in lead burning operations is lead fumes. The maximum allowable concentration for an eight-hour daily exposure to lead in the atmosphere is 0.15 mg./m.³ of air.

When lead burning is performed as a continuous operation at a fixed location, as on a workbench, a system of downdraft ventilation should be installed, consisting of a grille top workbench through which air is removed at a minimum rate of 200 c.f.m. per square foot of grille area.

When lead burning is performed as a continuous operation, but where some variation of the site is necessary, local exhaust ventilation should be provided by means of an adjustable, flexible tube with a mechanical source of exhaust ventilation. This tube should be three or four inches in diameter; the inlet should be located as close to the operation as practicable, and the source of exhaust should be sufficient to remove a minimum of 250 c.f.m. of air from each operating site.

When lead burning is a temporary or occasional operation, the workers should be required to use respirators approved by the U. S. Bureau of Mines for protection against lead fumes (type C supplied-air, if possible, otherwise mechanical-filter).

Lead Melting

The potential health hazards in lead melting operations are lead fumes and lead dust. The maximum allowable concentration for an eight-hour daily exposure to lead in the atmosphere is 0.15 mg./m.³ of air.

The melting pot or furnace should be enclosed with a hood and this hood should be connected to a source of mechanical exhaust ventilation capable of producing an air removal velocity of 100 f.p.m. at the hood openings. The fumes should be discharged to the outside atmosphere. The hood door should be closed except when it is necessary to remove melted lead from the furnace prior to pouring operations.

The principal source of lead is in the removal of lead dross

from the melting pot or furnace, and the deposition of this dross in a haphazard fashion upon the floor in the vicinity of the melting furnace or the molds. The lead dross should be removed carefully and deposited in a suitable receptacle which should be closed whenever possible by means of a tight-fitting cover.

Lead Pouring

The potential health hazards in lead pouring operations are lead fumes and lead dust. The maximum allowable concentration for an eight-hour daily exposure to lead in the atmosphere is 0.15 mg./m.³ of air.

The temperature of the molten lead should be kept as low as possible while still permitting the pouring operation. Good house-keeping should be maintained in the vicinity of the pouring operation, and periodic checks should be made for the presence of lead fumes and lead dust in the atmosphere.

The disposal of lead dross should be controlled as outlined under *Lead Melting* to minimize the exposure of the workers to lead dust. Care should be taken to deposit the dross within the receptacle provided, so that lead dust will be controlled effectively.

Leather Cleaning

The potential health hazards in leather cleaning operations are solvent vapors. Some of the more commonly used solvents are Varsol, carbon tetrachloride, ethylene dichloride, sulfur dioxide as an acid sulfite, and mineral cleaning oils; the established maximum allowable concentrations for some of these materials are listed in the table at the end of this chapter. Solvents of low toxicity should be used in all cases in leather cleaning.

If the concentration of a particular solvent vapor in the atmosphere exceeds the maximum allowable concentration, adequate general ventilation or a local exhaust ventilation system should be provided. If local exhaust ventilation is used, the air velocity at the source of the solvent vapor should be about 100 f.p.m.

Lens Cleaning

The potential health hazards in lens cleaning operations are solvent vapors. Some of the more commonly used solvents are xylene, coal-oil, higher alcohols, and the soapless cleaning compounds; the established maximum allowable concentrations for some of these materials are listed in the table at the end of this

chapter. Solvents of low toxicity should be used in all cases in lens cleaning.

If the concentration of a particular solvent vapor in the atmosphere exceeds the maximum allowable concentration, adequate general ventilation or a local exhaust ventilation system should be provided. If local exhaust ventilation is used, the air velocity at the source of the solvent vapor should be about 100 f.p.m.

Luminous Dial Painting

The potential health hazards in luminous dial painting and in the storage and handling of radioactive luminous compound incidental to dial painting are radioactive dust, gamma-rays, and radon, a gaseous decomposition product which is potentially dangerous when inhaled in excessive quantities. In addition to the commonly recognized luminous compounds, zinc sulfide, which has been given fluorescent properties by exposure to radium, should be handled with caution.

The exposure to gamma-rays should never exceed the rate of 0.1 roentgen per eight-hour working day per person. The maximum allowable concentration of radon gas in the atmosphere at any time is 10^{-11} curie per liter. See reference 17.

If the exposure to gamma-rays exceeds 0.1 roentgen per eight-hour working day per person, lead screening should be utilized to limit the exposure. The screening should conform to Failla's radium protection chart. See reference 18.

Control of radioactive dust and radon should be accomplished by (1) limiting the amounts of radioactive luminous compound issued to the workers, (2) partial or complete enclosure of processes, (3) the use of mechanical local exhaust ventilation, (4) general ventilation, (5) application of strict personal hygiene measures, and (6) personal respiratory protection.

Not more than the following amounts of radioactive luminous compound should be issued to each dial painter:

<i>Luminosity (Microlamberts)</i>	<i>Permissible Amount (Grams)</i>
0-12	20
12-38	10
38 or over	5

Where wet processing is impracticable in removing radioactive luminous compound preliminary to the repair or refinishing

ing, the article should be placed on a moist paper during the removal operation and the worker should wear a supplied-air (air-line) respirator approved by the U. S. Bureau of Mines for protection against toxic dusts. Such respirators should be worn by all persons exposed to dust from radioactive luminous compound, including weighing and compounding activities.

The *main sources of radon* in radium dial painting, handling and storage operations are: (1) the painting process itself and specifically from the paint stored in the container and being applied to the work, (2) the finished dials not yet removed to the drying cabinet, (3) the dials as they rest in the drying cabinet, (4) the storage cabinet preparatory to shipment, and (5) the storage cabinet at the point of use. Controls must be applied at these points.

Each dial painting bench should be equipped with a transparent hood which encloses the bench with the exception of an open working face, and which is exhausted mechanically at a minimum average rate of 50 f.p.m. (100 f.p.m. preferred) at the hood face. See U. S. Bureau of Standards Handbook H27 for hood specifications.

Cabinets in which painted dials are stored or dried should be ventilated at either of the following rates: (1) not less than 360 c.f.m. per 1,000 dials stored, (2 to 10 pointers equivalent to one dial), and (2) not less than that sufficient to produce an average face velocity of 75 f.p.m. across the cabinet doorway when the door is open.

In addition, general ventilation should be provided in all rooms in which radioactive luminous compound is used or handled so that the radon content of the air in the room should not exceed 10^{-11} curie per liter.

Every employee should be instructed in the handling of radioactive luminous compound and in the observance of all rules that immediately affect or concern his conduct. Proper supervision of all workers should be maintained to insure the observance of these rules.

All dial painters and others handling radioactive luminous compound should change clothing before and after each day, observe strict personal hygiene, and be inspected by supervising personnel under ultraviolet light for traces of radioactive luminous compound whenever they leave the workroom. If any of the compound is detected on the skin or clothing, it should be removed promptly.

For detailed information concerning the workrooms and equipment, inspection for hazards, transportation, and plant and personal hygiene, reference should be made to the U. S. Bureau of Standards Handbook H27, cited above.

Machining

Machining operations frequently involve the use of white lead and cutting oils. The potential health hazard is lead which may be ingested or absorbed through the skin directly or through the medium of the cutting oil.

A nontoxic lubricant should be used if possible in place of the white lead and all workers exposed to this hazard should observe strict personal hygiene, with particular attention to cleansing of hands before meals.

Magnesium Casting

This is a relatively new industry and presents some new potential hazards to health. The substances which are of concern as regards the health hazard are hydrogen fluoride, fluoride salts, and sulfur dioxide. The maximum allowable concentration for hydrogen fluoride is 3 p.p.m., and for sulfur dioxide is 10 p.p.m. based on an eight-hour daily exposure.

Whereas fluorides apparently are used in some magnesium casting, it has been found that their use is not essential, at least in some of the casting operations. Sulfur is used in the casting operation and sulfur dioxide is liberated during pouring; also, subsequent curing operations result in sulfur dioxide exposure. As a rule, the exposures are not serious and only under unusual conditions is a hazardous concentration encountered and then only for short periods. U. S. Bureau of Mines approved chemical-filter respirators (gas masks) for acid gases should be available for use when high concentrations are encountered.

Magnesium Screening (see Tracer Mix Preparation)

Mercury Crack Testing

The potential health hazard in mercury crack testing is mercury vapor. The maximum allowable concentration of mercury vapor for an eight-hour daily exposure is 0.1 mg./m.³

The work table upon which the cartridges are coated with mercury, the sink into which the mercurous nitrate is poured, and the stove used for heating the coated cartridges and cases should be provided with adequate ventilation by means of a

laboratory bench-type hood under which the operations are performed. This hood should be exhaust-ventilated at a minimum rate of 150 c.f.m. per square foot of face opening in the hood.

The use of pitchers rather than shallow glass dishes for the mercury coating process will tend to keep the mercury concentration lower since less surface is exposed in this manner. All mercury coated cases and cartridges should be discarded into a covered container and these containers should be removed frequently from the laboratory (at least twice per shift is necessary).

Rubber gloves and rubber aprons should be worn by the examiners during the visual inspection of the mercury coated cases and cartridges.

Where adequate control measures are not available or have broken down, U. S. Bureau of Mines approved chemical-filter respirators (gas masks) or supplied-air (air-line) respirators for mercury vapor should be worn as an emergency measure until the proper control measures are in operation.

Metal Cleaning (see Pickling)

Metal Finishing (Caustic Treatment to Produce a Gun-Metal Finish)

The health hazard in this operation results from exposure to the caustic mists and vapors liberated from the hot caustic solution into which the metal is dipped for treatment. The composition of the caustic solutions varies considerably and little is known concerning the maximum allowable concentrations; however, control measures are needed.

The caustic mists and vapors may be prevented from entering the general workroom air by the use of local exhaust ventilation at the hot caustic tanks. The recommended procedure consists of exhausting air at a minimum rate of 120 c.f.m. per square foot of tank area through slot-type lateral exhaust hoods located on one or both of the long sides of the tank.

Metal Spraying (Metalizing)

Metal spraying operations subject the operators to potential health hazards from carbon monoxide and metal fumes of all kinds including lead. The maximum allowable concentration of these metal fumes varies from as little as 0.15 mg./m.³ for lead to as much as 15 mg./m.³ for zinc and even more for iron.

Such operations should be performed in properly designed

booths which are exhaust-ventilated at the minimum rate of 200 c.f.m. per square foot of opening at the face of the booths, and the workers should always be on the clean air side of the object being sprayed.

Motor Testing

The potential health hazards in the testing of motors (tank, automobile, aviation engines, and so forth) are carbon monoxide and excessive noise. The maximum allowable concentration of carbon monoxide for an eight-hour daily exposure is 100 p.p.m. Testing motors in a fixed position requires the discharge of the exhaust gases to the outside air if workers are in the same room as the motor. If back pressure on the motor is of no consequence, the motor exhaust pipes may be extended to the outside. Where back pressure is not permissible, the motor exhaust pipes should enter a mechanically exhaust-ventilated duct from which air is removed in excess of the maximum rate of exhaust from the motor. In either case, the discharge should be located at a point where the contaminated air will not enter any occupied buildings.

When motors are tested on a moving assembly line, down-draft exhaust ventilation should be provided through grilles in the floor beneath the assembly line. Sufficient air should be removed to keep the *carbon monoxide concentration* in the general room air less than 100 p.p.m.

For automobile engine repair and test work, flexible metal ducts of suitable diameter to fit over the motor exhaust pipe should be used to convey the exhaust gas from the exhaust pipe to (1) a mechanically exhaust-ventilated gutter in the floor, (2) a mechanically exhausted duct, or (3) directly to the outside. If method (3) is used, the motor under test should be located as close as possible to the door or wall so that the length of flexible pipe is kept at a minimum. Good general room ventilation in addition is advisable.

Excessive *noise* should be controlled, if possible, by means of suitable sound baffles, sound absorbing materials, and enclosure of the source of noise. Where adequate control cannot be obtained by these methods, the exposed workers should wear suitable ear protective devices.

Nitration, Dimethylaniline Sulfate

The potential health hazards associated with DMAS nitration are nitrogen oxides. The maximum allowable concentration of

oxides of nitrogen for an eight-hour daily exposure is 25 p.p.m.

Since DMAS nitrators are enclosed and held under a slight negative pressure to remove the oxides of nitrogen liberated during the nitration reaction, there is little chance for oxides of nitrogen to be discharged to the general room air during normal operation. As an additional safety measure, the nitrators should have an auxiliary exhaust ventilation system to remove the nitrogen oxides in case of a breakdown or overloading of the exhaust system used to carry the nitrogen oxides to the acid recovery plant.

Nitrobenzene Distillation

The potential health hazard associated with nitrobenzene distillation is nitrobenzene vapor. The currently accepted maximum allowable safe concentration of nitrobenzene is 5 p.p.m.

The process should be completely enclosed and mechanical general room ventilation should be provided. Adequate ventilation may be provided by using roof ventilators equipped with mechanically operated fans. All doors and windows should be kept open as much as possible.

The overflow vents of the nitrobenzene storage tanks should extend outside the building to a point where the vapors will not reenter the building.

Nitrobenzene Neutralization, Separation and Storage

The potential health hazard associated with the neutralization, separation and storage of nitrobenzene is nitrobenzene vapor. The currently accepted maximum allowable concentration is 5 p.p.m.

The neutralization, separation and storage tanks should be completely enclosed. The overflow vents of the storage tanks should extend outside the building, at a point where the vapors will not reenter. Roof ventilators with mechanically operated fans should be provided for good general room ventilation.

Workers should observe strict precautions regarding general and personal cleanliness. Skin contact with nitrobenzene should be avoided.

Nitrocellulose Cutting and Graining

The potential health hazard found in cutting and graining of smokeless powder is from the ether and alcohol vapors.

Although the permissible safe concentrations are controver-

sial at present, an attempt should be made to keep the concentrations as low as is feasible and it is believed that they should never exceed a total of 1000 p.p.m.

In rifle powder graining the containers under the distributors should have a bottom made of wire screening or perforated metal and should be located on a grille over a well in the floor which is exhaust-ventilated. The ventilation rate should be as low as is consistent with adequate control; a minimum of 100 c.f.m. per square foot of grille area is suggested.

In powder cutting the containers of grained powder should be placed over a well in the floor similar to that advocated for powder graining. The local exhaust ventilation should be connected to the solvent recovery system. The buckets used to collect the cut powder should be constructed similar to those used for graining. By placing these over wells which are exhaust-ventilated, the vapors are prevented from escaping into the atmosphere.

In cold weather the supplied air should be introduced into the room at a low velocity to prevent a dangerous draft over the workers.

Nitroglycerine Neutralization and Washing

The potential health hazard associated with the washing and neutralization of nitroglycerine is inhalation of nitroglycerine vapor and skin contact with nitroglycerine. While the maximum allowable safe concentration for nitroglycerine has not been established, its toxicity is relatively high and therefore the atmospheric concentration should be kept as low as possible; all nitroglycerine neutralizing and washing operations should be enclosed as completely as possible, and good general room ventilation should be provided.

In addition to being absorbed by inhalation, nitroglycerine is absorbed readily through the skin. Therefore, special attention should be paid to housekeeping (cleanliness of workroom), and to personal hygiene, which should include changing work clothes daily, washing hands and face thoroughly before eating, taking shower at end of shift, and wearing protective clothing such as impervious gauntlets and gloves.

Nitrometer Operation

The principal health hazards associated with the nitrometer operation are mercury vapors and oxides of nitrogen. The maxi-

imum allowable atmospheric concentration of mercury vapor for an eight-hour daily exposure is 0.1 mg./m.³ while that of the oxides of nitrogen is 25 p.p.m.

Good housekeeping is essential in the prevention of mercurial poisoning. A collecting pan of sufficient size to receive any mercury spilled at the nitrometer should be installed just under the base supporting the nitrometer. The pan should slope to a central point and connect to a well to catch the spilled mercury. This well should be emptied frequently. The mercury should not be allowed to come in contact with any heated surface.

The nitrogen oxides from the nitrometer should not be permitted to enter the room air. These gases should be removed either by providing lateral mechanical exhaust ventilation at the point of discharge of the nitrogen oxides or by locating the nitrometer near a laboratory exhaust hood and attaching one end of a glass or rubber tube to the gas discharge end of the nitrometer and extending the other end of the tube well up into the laboratory exhaust hood or duct.

Paint Drying

The potential health hazard associated with drying painted articles is the vapor of the paint solvent. The toxicity of these solvents varies from the very toxic benzene to the relatively non-toxic acetone. The maximum allowable safe concentrations in the atmosphere for some of these solvents are listed in the table at the end of this chapter.

Drying of painted articles should be carried out in enclosed drying ovens provided with mechanical exhaust ventilation. The air removal rate should be sufficient to provide a minimum air velocity of 100 f.p.m. across the face of all openings in the drying oven. The point of discharge of the exhausted air should be so located that the vapors cannot reenter any occupied building.

Painting, Brush

The potential health hazards associated with brush painting are the paint pigments and the vapor of the paint solvent. Some of the more toxic pigment ingredients are lead and antimony, whereas the relatively harmless ingredients include zinc and iron. The toxicity of the solvents varies from the highly toxic benzene to the relatively non-toxic acetone. The maximum permissible safe concentrations for some of the solvents and pigment ingredients are listed in the table at the end of this chapter.

The important methods for controlling the health hazards of brush painting are: (1) the use of paints having relatively harmless solvents and pigments, (2) the use of adequate ventilation, (3) the use of suitable personal protective devices, and (4) good personal hygiene.

For the purpose of this discussion, only brush painting pertaining to the repair or construction of buildings and equipment will be considered. Where brush painting is part of a production job, the control measures listed under spray painting (*Painting, Spray*) should be applied.

Even though good ventilation is needed for brush painting of all kinds, special attention should be paid to the ventilation when paints containing the more toxic ingredients are used. Good natural ventilation provided by open doors and windows will suffice in large airy rooms, whereas some mechanical means such as a fan or blower will be needed to provide ventilation in smaller rooms where painting is being done.

For painting in small enclosed spaces, a supplied-air respirator approved by the U. S. Bureau of Mines should be used if definite mechanical ventilation is impracticable.

Good personal hygiene is very important in all manual painting. The hands and face should be kept clean by frequent and thorough washing, clothes should be changed frequently, dirty hands and soiled objects should be kept out of the mouth, and other items of personal cleanliness should be practiced.

Painting, Spray

The potential health hazards associated with spray painting are the paint pigments and the mist and vapor of the paint solvent. Some of the more toxic pigment ingredients are compounds of antimony, lead, and other toxic metals whereas the relatively harmless ingredients include zinc and iron. The toxicity of the solvents varies from the very toxic benzene to the relatively non-toxic acetone. The maximum permissible safe concentrations for some of the solvents and pigment ingredients are listed in the table at the end of this chapter.

The important methods for controlling the health hazards of spray painting are: (1) the use of paints having relatively harmless solvents and pigments, (2) the use of mechanically exhaust-ventilated spray paint booths and rooms, (3) the use of suitable personal protective devices, and (4) good personal hygiene.

All spray paint booths and rooms should be mechanically

ventilated at rates given below and the discharge should in all cases be located at a point where the contaminated air will not reenter any building.

Spray painting should be done in mechanically exhaust-ventilated spray paint booths, preferably of the water curtain type. The painting operation should be an automatic one on all production work, if practicable. The object being painted should be supported by a jig or other suitable mechanical device and should be located well within the confines of the booth.

Small spray painting booths (those having face areas of less than 50 square feet) should have a minimum exhaust ventilation rate of 200 c.f.m. per square foot of face area of the booth, whereas a minimum of 150 c.f.m. per square foot of face area will suffice for larger booths. The air velocity should be essentially uniform across the entire face of the booth.

Downdraft exhaust ventilation through a grid type floor is advisable in booths or rooms where cars, trucks and other large objects are spray-painted. A minimum air velocity of 150 f.p.m. toward the grids should be maintained at the painting location. However for intermittent painting operations of this nature any well ventilated room is satisfactory if the worker wears at all times while in the room a supplied-air (air-line) respirator approved by the U. S. Bureau of Mines.

Wherever it is necessary for the painter to work downstream (as regards air movement) of the object being painted or if the object being painted is large so that the painter is exposed to the paint mist, he should wear a supplied-air (air-line) respirator approved by the U. S. Bureau of Mines. Also all painters who use spray guns for painting in the repair and construction of buildings and equipment should wear approved supplied-air respirators at all times while painting.

In rare instances for intermittent operations, it will be found to be more feasible to provide the sprayer with a supplied-air hood covering the entire head than to provide the large amount of ventilation necessary to control adequately the exposure. In such cases, the use of supplied-air hoods is permissible.

Good personal hygiene as given under brush painting (*Painting, Brush*) should be practiced.

Paint Manufacture, Camouflage (see Camouflage Paint Manufacture)

Pellet Density Testing

The principal health hazard associated with the tetryl pellet density testing operation is that of mercury vapor. The maximum allowable atmospheric concentration of mercury vapor for an eight-hour daily exposure is 0.1 mg./m.³

Although this operation is usually intermittent, any spilled mercury gives rise to a constant exposure. Good housekeeping is essential in the handling of mercury. Pellet density testing should not be done in areas adjacent to heated surfaces such as radiators or hot water pipes, and should preferably be done in areas having good general ventilation. The operations in density testing should be done on a large tray having a flanged edge and sloping to one corner containing a well. The mercury should be removed from the well frequently, and all mercury not in use should be kept in closed containers.

Pickling

The potential health hazards found in pickling are acid mists, acid gases, and gases liberated due to impurities either in the pickling acid or the metal being cleaned. The maximum allowable concentration in the atmosphere for some of these are:

Hydrogen chloride	10 p.p.m.
Hydrogen sulfide	20 p.p.m.
Sulfur dioxide	10 p.p.m.
Arsine	1 p.p.m.
Phosphine	1 p.p.m.
Nitrogen oxides	25 p.p.m.

The acid mists and gases liberated during pickling operations should be prevented from entering the room atmosphere by enclosing or partially enclosing the tank if possible and by providing mechanical exhaust ventilation at the enclosure. The rate of ventilation should be sufficient to produce an air movement into the enclosure of at least 100 f.p.m. at all openings. Where enclosure is not practicable, local exhaust ventilation should be provided at the tank by means of slot-type hoods at the upper perimeter of the tank. The minimum required ventilation rate will vary with the nature of the operations but should never be less than 120 c.f.m. per square foot of tank area. The exhaust system should be constructed of acid resisting material and the exhausted air should be discharged at a point where it will not reenter occupied buildings.

Pickling operators should wear acid-proof protective clothing and should practice good personal hygiene.

Pontoon (Rubber) Manufacture (see Rubber Goods Fabrication)

Primer Mixture Screening

The potential health hazards of primer mixture screening are the dusts from the various ingredients of the primer mixture. The maximum allowable concentration of lead thiocyanate in terms of lead is 0.15 mg./m.³ of air while the currently accepted maximum allowable concentration of TNT in the atmosphere is 1.5 mg./m.³ Although the maximum allowable concentrations of many of the primer mixture ingredients are not known, they should be kept as low as is possible with good engineering practice.

Screening of the various ingredients of the primer mixture should be done in an enclosed system. This may be accomplished by providing a tight-fitting cover for the screen, and either attaching the receptacle directly to the screen or using a flexible dust-proof sleeve to connect the receptacle to the screen. Since the exposure is intermittent and for only brief periods of time and since the workers on this job are usually rotated, the most practicable control method is personal respiratory protection. The respirators (mechanical-filter type) should be approved by the U. S. Bureau of Mines and should be cleaned and repaired daily by one individual who should be assigned to this task.

Printing (Cleaning Type and Presses)

The potential health hazards in printing operations are solvent vapors. Some of the solvents commonly used to clean type and presses are benzene, carbon tetrachloride, methyl alcohol, and trichlorethylene.

The maximum allowable atmospheric concentrations for an eight-hour daily exposure to these solvents are:

Benzene	100 p.p.m.
Carbon tetrachloride	100 p.p.m.
Methyl alcohol	200 p.p.m.
Trichlorethylene	200 p.p.m.

No cleaning compounds containing any considerable amounts of benzene, carbon tetrachloride, or methyl alcohol should be used; suitable solvents which are less toxic should be used.

The printing room should be large and have good natural ventilation. Mechanical exhaust ventilation fans should be lo-

cated in roof ventilators if the room is small and the amount of work sufficient to raise the concentration of the solvents above the maximum allowable concentration.

Protectoscope Manufacture

In the manufacture of protectoscopes for tanks, a mirrored surface is coated with plexigum in ethylene dichloride. The maximum allowable concentration for ethylene dichloride is believed to be about 100 p.p.m. The exposures commonly encountered in these operations produce nausea and vomiting.

Owing to the nature of the operation, it is usually carried out in a room devoid of mechanical ventilation, and local exhaust ventilation likewise is impracticable because of the formation of bubbles on the mirrored surface. The exposures are usually of short duration and may be controlled effectively by the use of U. S. Bureau of Mines approved chemical-filter respirators (gas masks) for protection against organic vapors.

Rosin Melting (Melting Rosin for Filling Shrapnel Projectiles)

The health hazard in this operation is the exposure to decomposition products of the melted rosin at the temperature usually employed (400 to 450° F.). These products are acid in reaction and are very irritating to the mucous membranes of the operators.

The hazard should be controlled by partly enclosing the rosin melting pot and providing exhaust ventilation at the enclosure of not less than 100 c.f.m. per square foot of opening in the enclosure.

Rubber Boat Manufacture (see Rubber Goods Fabrication)

Rubber Goods Fabrication

The potential health hazard associated with the fabrication of rubber goods is the rubber or rubber cement solvent. Various solvents are used including carbon disulfide, benzene, toluol, xylol, carbon tetrachloride, methyl ethyl ketone, petroleum naphthas, and ethylene dichloride. The maximum allowable concentrations of these solvents vary from as little as 20 p.p.m. for carbon disulfide and 100 p.p.m. for benzene to as much as 1000 p.p.m. for the petroleum naphthas. Sometimes the petroleum naphthas contain such aromatics as trimethyl benzenes, ethyl benzenes, and other benzene homologues which serve to increase their toxicity.

Inasmuch as the solvents in the rubber cements may be unknown or may vary from lot to lot, the control measures must be based on the assumption that the solvent is benzene, unless it is known to be otherwise, in which case the control measures may be relaxed accordingly. The operations vary considerably and include cementing operations on benches, on the floor, or on large objects at work-bench height; coating materials in mechanically operated spreaders; and the like. The exposure at some of these operations may be controlled by providing good general ventilation of the workroom. For some operations in small rooms as much as 40 to 80 air changes per hour are needed. (The minimum required ventilation may be computed by the equation

$Q = \frac{X}{m}$ described earlier in this chapter.) However, in many

instances, general ventilation does not suffice. In such cases, local exhaust ventilation should be used if practicable; otherwise, suitable respirators (supplied-air respirators approved by the U. S. Bureau of Mines) should be used. The type of local exhaust ventilation which should be employed will depend upon many circumstances. Ventilation through grilles in the tops of the work benches serves admirably if the material being fabricated does not cover the entire bench. If it does, lateral exhaust hoods along one or both sides of the bench may be employed. If neither bench top nor lateral exhaust ventilation is practicable, updraft ventilation through hoods located above but as close to the work as feasible may be satisfactory. In general, these operations vary sufficiently to make each a distinct problem which can be solved only by careful study of the operation. In any event, the quantity of air removed should be sufficient to provide a minimum velocity toward the exhaust hood of 100 f.p.m. at the source of contamination.

If the solvent odor persists, the actual exposures should be determined to decide whether additional ventilation is necessary or whether respirators must be used.

Sand Mixing and Screening

The potential health hazard associated with sand mixing and screening operations is silica dust. The maximum allowable concentration of free silica is 5 million particles per cubic foot of air as determined by the standard light field technique.

Inasmuch as dry sand mixing and screening operations produce an enormous amount of silica dust, these operations should

be enclosed as much as possible and provided with local exhaust ventilation. Owing to the large number of ways these operations are carried out, no specific type of exhaust ventilation system can be suggested. However, the dust is usually controlled successfully if the ventilation rate is such that the air velocity toward the exhaust inlet is about 250 f.p.m. at the source of dust production. Periodic dust counts should be made in the area adjacent to these operations to check the performance of the exhaust ventilation system.

The exhausted air should be passed through a suitable collector to remove the dust before the air is discharged to the outside. The discharge outlet should be so located that the air will not reenter the buildings and in no case should the air be recirculated into the workroom even if the dust collector appears to be efficient. The collector should be cleaned frequently and routinely and should be maintained in good working condition.

A local exhaust ventilation system may not be necessary if the sand mixing and screening operations are intermittent so that the average exposure of the worker to silica dust is low. In such instances, the operations should be isolated to avoid exposing other workers to the dust and the exposed workers should wear respirators approved by the U. S. Bureau of Mines for protection against silica dust.

Self-sealing Fuel Tank Manufacture (see Rubber Goods Fabrication)

Shell Case Manufacture

A potential health hazard from metal fumes is encountered in the melting of brass in the initial billet casting operation. These fumes may be relatively toxic if the brass contains considerable lead (cartridge brass seldom contains lead) or they may be largely zinc oxide fumes. The maximum allowable concentration for lead in the atmosphere is 0.15 mg./m.³ and for zinc oxide, 15 mg./m.³, based on an eight-hour daily exposure.

The exposure may sometimes be controlled adequately by good general ventilation whereas in many instances local exhaust ventilation through hoods located above the melting pots is necessary. The required ventilation rate varies tremendously, depending upon circumstances, but should be sufficient to remove all the contaminated air from the vicinity of the melting pot.

Shrapnel Projectile Loading (see Rosin Melting)

Smokeless Powder Cutting and Graining (see Nitrocellulose Cutting and Graining)**Soldering**

The potential health hazards associated with soldering operations are lead fumes and hydrogen chloride gas from the acid flux. The maximum allowable concentration for an eight-hour daily exposure to lead fumes in the atmosphere is 0.15 mg./m.³ and to hydrogen chloride gas, 10 p.p.m.

Control measures should consist of local exhaust ventilation, general ventilation, and the use of personal respiratory protective devices, according to the nature of the operation. All soldering sites should have good natural ventilation, if possible.

Continuous or production soldering operations require local mechanical exhaust ventilation for the removal of lead fumes and acid gas. The workbench should be equipped with a grille-top through which the air is exhausted at the minimum rate of 100 c.f.m. per square foot of grille area. In addition, the stove or heater for the iron should be enclosed on three sides in a hood which is exhaust ventilated at the rate of about 100 c.f.m. per square foot of opening in the hood. The exhausted air should be discharged to the outside atmosphere in such a manner that it will not reenter the building.

For intermittent soldering operation of a repair nature, good general ventilation will control the exposure adequately.

For all operations which are done in confined spaces, adequate ventilation should be provided by any suitable means such as a portable blower, fan, or air-operated ejector, or if this is impracticable, suitable respiratory protective devices should be worn. If an acid free flux is used, a mechanical-filter respirator approved by the U. S. Bureau of Mines for toxic dusts will suffice; otherwise, an approved supplied-air (air-line) respirator will be needed.

Spray Coating (see Painting, Spray)**Stenciling** (see Painting, Spray)**Sulfation, Dimethylaniline** (see Dimethylaniline Sulfation)**Sweetie Barrel Operation**

The principal potential health hazard associated with the sweetie barrel operation is dinitrotoluene in the form of dust,

fume, and vapor. While no maximum allowable atmospheric concentration has been established for DNT, it is believed to be of the same order of toxicity as TNT. The currently accepted maximum allowable atmospheric concentration for an eight-hour daily exposure to TNT is 1.5 mg./m.³

All weighing and sweetie barrel operations should be isolated insofar as it is practicable. Mechanical-filter respirators or supplied-air (air-line) respirators approved by the U. S. Bureau of Mines for protection against toxic dusts should be worn by the workers while scraping the insides of the sweetie barrels, and while holding the bags receiving the discharge from the sweetie barrels.

Tank (Aircraft Fuel) Manufacture (see Rubber Goods Fabrication)

Testing, Ballistics (see Ballistics Testing)

Tetryl Blending

The potential health hazard in tetryl blending is tetryl dust. Although no maximum allowable concentration has been established for tetryl dust in the atmosphere, the concentration of the dust should be maintained as low as possible within the limits of good engineering practice. It is suggested that the atmospheric concentration of tetryl be maintained below a value of 1.5 mg./m.³ wherever practicable.

During periods of filling and discharging of the blender, a dust-tight connection should be maintained between the tetryl screen and the blender, and a dust-tight sleeve should be attached to the discharge end of the blender and should extend to the bottom of, or be removably attached to, the receiving unit. If the sleeve extends to the bottom of the receptacle, it should be manipulated by hand to release the tetryl with a minimum of dusting.

If the above suggestions do not reduce the atmospheric concentration of tetryl dust below 1.5 mg./m.³, mechanical-filter respirators approved by the U. S. Bureau of Mines should be worn by the workers while in the blending room.

Tetryl Crystallization

The potential health hazards in the tetryl crystallization operations are benzene vapors and acetone vapors. The maximum allowable concentration for an eight-hour daily exposure to ben-

zene in the atmosphere is 100 p.p.m. and while no maximum permissible safe limit has been established for acetone, it is known to be relatively non-toxic.

A substitute for benzene should be used if possible and the necessary precautions should be observed in handling the substituted solvent.

If benzene is used, the process should be enclosed as much as possible and adequate mechanical local exhaust ventilation should be provided at the vacuum pan. The rate of air removal at the source of benzene vapors should be not less than 100 f.p.m.

Tetryl Drying

The potential health hazard in tetryl drying operations is tetryl dust which is generated during the loading and unloading of drying screens in the tetryl dry house. The concentration of tetryl dust in the atmosphere should be maintained as low as possible within the limits of good engineering practice. A maximum concentration of 1.5 mg./m.³ is suggested. See *Tetryl Blending*.

A system of mechanical local exhaust ventilation should be installed to remove tetryl dust generated during the drying screen loading and unloading operations. The system should be such that the air movement is at least 100 f.p.m. at all points of dust production. If the use of local exhaust ventilation is impracticable or inadequate, the workers should wear respirators approved by the U. S. Bureau of Mines for protection against toxic dusts.

Due precautions should be observed with regard to the collection of tetryl dust in the duct work of the ventilating system, and with regard to the disposition of the dust removed by the ventilating system. A wet type collector located as close as possible to the source of dust removal is suggested for filtering the dust from the air before it is discharged to the outside.

Tetryl Mixing with TNT

The potential health hazards in the mixing of tetryl with TNT are tetryl dust and TNT vapors and fumes. The currently accepted maximum allowable concentration of TNT in the atmosphere is 1.5 mg./m.³ and a maximum atmospheric concentration of 1.5 mg./m.³ is suggested also for tetryl. See *Tetryl Blending*.

The mixing process should be partially enclosed and controlled by a mechanical exhaust system which produces an air movement of at least 100 f.p.m. at the face of the hood opening.

Tetryl Packing

The potential health hazard in tetryl packing operations is tetryl dust. The tetryl concentration in the atmosphere should be maintained below 1.5 mg./m.³ wherever feasible. See *Tetryl Blending*.

Local exhaust ventilation should be applied near the chute discharge from the tetryl hopper to the tetryl boxes at the source of tetryl dust. The rate should be sufficient to prevent the escape of dust into the atmosphere; a minimum velocity of 200 f.p.m. at the source of dust production is suggested.

Tetryl Pellet Density Testing (see Pellet Density Testing)

Tetryl Pelleting

The potential health hazard in tetryl pelleting operations is tetryl dust. The tetryl concentration in the atmosphere should be maintained below 1.5 mg./m.³ wherever feasible. See *Tetryl Blending*.

In most instances the only atmospheric exposure to tetryl dust in tetryl pelleting occurs during the filling of the pelleting hopper and cleaning of the pelleting machine. Since these operations are intermittent and brief, the workers may be adequately protected by the use of respirators approved by the U. S. Bureau of Mines.

Tetryl Reaming

The potential health hazard in tetryl reaming operations for fuzes is tetryl dust. The tetryl concentration in the atmosphere should be maintained below 1.5 mg./m.³ wherever feasible. See *Tetryl Blending*.

A mechanical local exhaust system should be installed to control the tetryl dust at its source. The rate of air movement should be at least 100 f.p.m. at the source of the dust.

Tetryl Screening

The potential health hazard in tetryl screening operations is tetryl dust. The tetryl concentration in the atmosphere should be maintained below 1.5 mg./m.³ wherever feasible. See *Tetryl Blending*.

To accomplish the best results and to insure safe working conditions, the entire screening process, including the charging and discharging, should be enclosed as much as possible and

provided with exhaust ventilation at a rate which will produce an air velocity into all openings of not less than 100 f.p.m. and should be about 300 f.p.m. at the openings or leaks at the screen where the dust is liberated with considerable velocity. The charging hopper and the receptacles should be attached to the screen by means of flexible dust-tight sleeves. The exhausted air should be conveyed to a wet collector located as close to the source of dust as possible and consideration should be given to keeping the duct work upstream of the collector free from tetryl deposits. Partial enclosure of the charging hopper with one side open for charging will aid in the prevention of atmospheric contamination at this point. At the discharges (both the coarse and fine outlets) the flexible dust-tight sleeve attached to the screen outlets should be permanently attached to a receptacle cover which may be transparent, if necessary. If this is not practicable, a ventilated canopy-type hood should be attached to the sleeve and located above but as close as possible to the receptacle. The minimum ventilation rate through the canopy hood should be 300 c.f.m. per square foot of opening between the receptacle and hood perimeter.

If the operation is intermittent or if exhaust ventilation is impracticable, the charging hopper should be entirely enclosed and provided with a door large enough to receive a box of tetryl and with a frame and crank such that a box of tetryl may be held in the frame and inverted by means of the crank outside the enclosure while the door is closed; also the hopper and receptacle should be connected to the screen by means of flexible dust-tight sleeves, and the workers should wear at all times while in the screening room mechanical-filter respirators approved by the U. S. Bureau of Mines for toxic dusts.

Tinning Process, Cold (see Cold Tinning Process)

TNT Break-Up (see Amatol Break-Up)

TNT Cooling

The operation in which tubs of liquid TNT are cooled to the desired temperature before pouring, presents an exposure to TNT vapor and fume. The maximum allowable safe concentration for atmospheric TNT is 1.5 mg./m.³

If the cooling tubs are stirred manually or if a number of tubs are cooling at the same time in a bay or room, the atmos-

pheric contamination in the room will be excessive. This condition may be prevented by (1) providing exhaust ventilation at each tub, or (2) ventilating the bay or room adequately. It is preferable that the tubs be stirred mechanically, but if each tub is ventilated properly, this is not essential.

Each tub may be ventilated adequately by installing a partially enclosing or a semicircular hood at the locations where the tubs are stirred so that when the tubs are in cooling position the enclosure or hood will be close to and almost adjoining the kettle. The recommended minimum exhaust ventilation rate for a hood is 120 c.f.m. per square foot of tub area and for a partial enclosure is 100 c.f.m. per square foot of opening in the enclosure. A suitable collector (preferably wet) should be located as close to the hoods or enclosures as possible so that the contaminated air is conveyed only a short distance in the duct work.

If local exhaust ventilation is impracticable, the contamination may be prevented from escaping into adjoining rooms by exhaust-ventilating the cooling bay or room at a minimum rate of 50 c.f.m. per square foot of opening into the bay. If general ventilation is used, the workers should wear U. S. Bureau of Mines approved mechanical-filter respirators at all times while in the cooling bay.

TNT Drying

The potential health hazard in TNT drying operations is TNT in the form of vapor and fume. The currently accepted maximum allowable concentration for TNT in the atmosphere is 1.5 mg./m.³

This operation should be completely enclosed to prevent the contamination of the atmosphere with TNT vapor. Provision should be made to exhaust the vapor from the drier to the outside atmosphere.

TNT Flaking

The potential health hazard in TNT flaking operations is TNT in the form of vapor, dust and fume. The currently accepted maximum allowable concentration of TNT in the atmosphere is 1.5 mg./m.³

The flaking machine should be partially enclosed and mechanically exhaust-ventilated at a rate sufficient to produce a velocity into the enclosure of at least 150 f.p.m. at all openings.

TNT Graining

The potential health hazard in TNT graining operations is TNT vapor and dust. The currently accepted maximum allowable concentration for an eight-hour daily exposure to TNT in the atmosphere is 1.5 mg./m.³

Each graining kettle should be enclosed completely by a hood which has an observation lid that may be opened; the hood should be exhausted mechanically at a rate sufficient to produce an air velocity of at least 100 f.p.m. at the hood face when the observation lid is open. All contaminated air should be discharged to the outside atmosphere in such a manner that it will not reenter the building.

TNT Melting

The potential health hazard in TNT melting operations is TNT vapor, fume and dust. The currently accepted maximum allowable concentration for an eight-hour daily exposure to TNT is 1.5 mg./m.³

The melting kettles should be enclosed and should be mechanically exhaust ventilated. The enclosure should be provided with the necessary number of lids or access doors which may be opened. The exhaust ventilation rate should be such that the air movement at the hood face when one lid is open is not less than 100 f.p.m.

In filling the TNT hoppers above the melting units, precautions should be observed to create as little dust as possible. If these hoppers are of good design and the charging is done properly, no atmospheric dust hazard should exist. However, if the concentration of TNT in the atmosphere during the filling operation exceeds 1.5 mg./m.³, the workers should wear respirators approved by the U. S. Bureau of Mines.

TNT Metal Tub Cleaning (see also Amatol Bucket Cleaning)

The potential health hazard in TNT metal tub cleaning operations is TNT dust. The currently accepted maximum allowable concentration of TNT in the atmosphere is 1.5 mg./m.³

For intermittent operations, mechanical-filter respirators approved by the U. S. Bureau of Mines should be worn by workers engaged in metal tub cleaning.

For continuous operations, the work should be done in mechanically ventilated exhaust booths which have a face velocity of not less than 200 f.p.m. and the operator to avoid excessive

exposure should remain upstream of the tub at all times while cleaning. The exhausted air should be discharged at a point on the outside where it will not reenter the buildings. Consideration should be given to the safety hazard associated with the collection of TNT dust in the ductwork; a wet collector close to the booth is suggested.

TNT Pouring and Puddling (see Amatol Pouring and Puddling)

TNT Purification

The potential health hazard in TNT purification operations is TNT vapor and fume. The currently accepted maximum allowable concentration of TNT in the atmosphere is 1.5 mg./m.³

The TNT purification process should be entirely enclosed to prevent the contamination of the workroom atmosphere.

TNT Screening

The potential health hazard in TNT screening operations is TNT dust. The currently accepted maximum allowable concentration of TNT in the atmosphere is 1.5 mg./m.³

Local exhaust ventilation is required at all TNT screening operations to maintain healthful working conditions. Suitable hoods with wet collectors are needed at the charging and discharging operations, and the screen proper should be dust-tight.

The hopper from which TNT is fed onto the screen should be partially enclosed with a canopy type hood which has an opening at one side to permit charging and, if necessary, a second opening to permit breaking clumps, hoeing or inspection. The minimum exhaust ventilation rate must be 300 c.f.m. per square foot of opening in the hood if the atmospheric contamination is to be controlled adequately. The paper liners should be folded at one of the hood openings to control the dust from this source.

The screen discharge should be provided with adequate local exhaust ventilation through a flanged conical type hood located above the receptacle or through a lateral hood. The recommended minimum ventilation rate is such that a velocity of 300 f.p.m. is maintained at the dust source.

Connections between the charging hopper and the screen and between the screen and the hood or receptacle should be made by means of flexible dust-tight cloth sleeves. A wet collector should be located adjacent to each local exhaust hood to remove the TNT from the air before it enters the ductwork or fan.

Wherever the TNT dust concentration exceeds 1.5 mg./m.³

in the workroom atmosphere, workers exposed should wear mechanical-filter respirators approved by the U. S. Bureau of Mines.

Toluene Nitration

The potential health hazards associated with the nitration of toluene are toluene, nitrogen oxides, mononitrotoluene, dinitrotoluene, and TNT. The currently accepted maximum allowable concentrations of these substances for an eight-hour daily exposure are as follows:

Toluene	200 p.p.m.
Nitrogen oxides	25 p.p.m.
Mononitrotoluene	Similar to nitrobenzene, which is generally 5 p.p.m.
Dinitrotoluene	Similar to TNT
TNT	1.5 mg./m. ³

All toluene nitrators should be enclosed and connected to an acid recovery plant by means of a local exhaust ventilation system. The nitrators should be held under a sufficient negative pressure to prevent the escape of nitrogen oxides into the room atmosphere during the nitration operation. As an additional protective measure, an auxiliary exhaust system should be installed on all nitrators for use in case of a breakdown or overloading of the regular exhaust system.

The observation section of the drain pipe leading from the nitrator should also be provided with local exhaust ventilation to prevent escape of nitrogen oxides and other toxic materials into the room atmosphere during the separating operation.

Tracer Bullet Charging

The potential health hazards in the charging of copper jackets with tracer mixture and igniter mixture are the tracer and igniter mixture dusts and the solvent vapors (carbon tetrachloride and methyl alcohol) resulting from the removal of the dusts from the charging machines and from the washing of the dies. The maximum allowable concentration of tracer mixture and primer mixture are not known but it is believed that no harm will result to the workers if the total dust concentration is kept below 5.0 mg./m.³ and the barium peroxide concentration below 0.5 mg./m.³. The allowable concentration of carbon tetrachloride in the atmosphere is 100 p.p.m. while that for methyl alcohol is 200 p.p.m.

General room ventilation should be provided to keep the tracer and igniter mixture dust in the air near the charging machines

and in the breathing zone of the workers below the allowable limit. Mechanical air conditioning with sufficient air changes per hour should be satisfactory if the air is not recirculated. If recirculation of part of the air is necessary, an efficient collector for both the dusts and vapors is necessary in the conditioning system to remove the contaminating materials from the air before recirculation. All charging machines should be cleaned at least once an hour, and oftener, if necessary. Air blowing of the dust on the machines should not be permitted; a commercial vacuum cleaning apparatus with an efficient filter should be used. Trichlorethylene, ethyl alcohol and coal oil should be used for wiping the machines and cleaning the dies; the use of carbon tetrachloride and methyl alcohol should be avoided.

Tracer Mixture Blending

The potential health hazard during tracer mixture blending operations is tracer mixture dust. Although the specific maximum allowable concentration of tracer mixture dust has not been determined, it is believed that the total amount of this dust in the workroom atmosphere should not exceed 5.0 mg./m.³

A flexible dust-tight sleeve or boot should be attached to the outlet of the blender and should either be attachable to the top of the receptacle by means of a dust-tight connection or extend to the bottom of the receptacle so that the dust created in the fall is not permitted to escape into the workroom atmosphere. With the latter arrangement, the sleeve should be manipulated by hand and care should be taken to avoid any unnecessary disturbance which would disseminate dust into the air. If the total tracer mixture dust content in the air exceeds 5.0 mg./m.³, the workers should wear mechanical-filter respirators approved by the U. S. Bureau of Mines. This may be necessary, particularly when charging the blender. The operators should practice good personal hygiene and good housekeeping.

Tracer Mixture Screening and Mixing

The potential health hazards of the tracer mixture screening and mixing operations, when conducted in the same room, are tracer mixture constituent dusts and carbon tetrachloride vapor. The maximum allowable concentration for carbon tetrachloride in the atmosphere is 100 p.p.m. Although the specific maximum allowable concentration for tracer mixture dust in the atmosphere has not been determined, it is believed that the total amount

of this dust in the workroom atmosphere should not exceed 5.0 mg./m.³

If possible, precipitated calcium resinate should be used in the preparation of tracer mixture, thereby eliminating the necessity of using carbon tetrachloride. If carbon tetrachloride is used, all of the air contaminated with the carbon tetrachloride vapors should be exhausted directly to the outside atmosphere.

Dust producing operations should be done in mechanically exhaust-ventilated hoods which have a minimum face area consistent with proper performance of the operations. The average hood face velocity for the control of operations which produce only a slight amount of dust may be as low as 100 f.p.m. but the average hood face velocity at very dusty operations should be not less than 150 f.p.m. In all instances, the hood design should be such that the necessary minimum control velocities exist in the zone of dust production.

Welding (Oxyacetylene and Electric)

The potential health hazards found in oxyacetylene and electric welding are fumes, gases, and infra-red and ultraviolet radiation. On some welding or cutting operations, such as the repair of ships or other painted structures, severe exposures to lead may result from the paint, or to mercury if mercury containing anti-fouling paint had been used. Also where welding rods having fluoride fluxes are used, there is an exposure to hydrogen fluoride and volatile fluoride salts. The maximum allowable concentrations on the basis of eight hours' daily exposure for some of the substances which may be encountered are:

Mercury	0.10 mg./m. ³
Lead	0.15 mg./m. ³
Hydrogen fluoride	3 p.p.m.
Nitrogen oxides	25 p.p.m.
Zinc oxides	15 mg./m. ³

Welding sites should be isolated from nearby workers by the use of screens or shields which protect the surrounding workers from the injurious light rays. At the same time these shields should not be more enclosing than necessary lest the ventilation at the welding site be reduced more than is desirable. Goggles, shields or helmets and other necessary protective clothing should be worn by the welders to protect their eyes and skin from the infra-red and ultraviolet radiation given off while welding.

The fume and gas hazard may be controlled by (1) ventila-

tion, and (2) personal protection. Wherever practicable, local exhaust ventilation should be employed and in other cases either general ventilation alone or general ventilation supplemented by respiratory protective devices is necessary. On routine operations, at more or less permanent locations or in places where continuous welding is done and conditions permit, local exhaust ventilation should be provided. For those operations where the welder moves about, a 3- or 4-inch flexible metal hose may serve as the hood and exhaust duct. Some systems are available also in which the flexible hose is counterweighted and the terminal end or hood is readily adjustable to any location. The minimum amount of air which must be exhausted from each welding operation is 250 c.f.m. and may be as high as 1,200 c.f.m. where large amounts of fumes and gases are produced. The exhaust hood should be kept as close to the operation as possible and should never be more than 12 or 15 inches away.

If welding is done in the open, natural ventilation is usually sufficient to prevent a health hazard. When welding in small enclosed spaces, the welder should wear an approved respirator of the supplied-air type (air-line) if adequate local exhaust ventilation is impracticable.

In many types of resistance welding, for example, seam and spot welding, ultraviolet and infra-red rays are not produced. However, welding fumes and gases are produced. If the amounts of toxic material in the atmosphere near such operations exceed the maximum permissible safe concentrations, and if workers are located in these areas, sufficient local exhaust ventilation should be provided to control the hazard.

Wood Veneer Processing

In the manufacture of airplane wings, propellers and other similar products from laminated wood, the component parts are dipped in phenolic resins which are heated and subjected to pressure. In such operations, there is a potential exposure to high atmospheric concentrations of phenolic resins unless appropriate control measures are observed. The maximum allowable concentration of this material has not been determined, but it is known to be quite toxic.

The dipping operation should be carried out in an exhaust-ventilated spray booth similar to a spray-painting booth. The ventilation rate through the booth should be not less than 100 c.f.m. per square foot of booth opening.

TABLE 3.—TOXIC LIMITS OF VARIOUS SUBSTANCES

<i>Substance</i>	<i>Maximum Allowable Concentration*</i>
Acrolein.....	1 p.p.m.
Acrylonitrile.....	20 p.p.m.†
Ammonia.....	100 p.p.m.
Amyl acetate.....	400 p.p.m.†
Aniline.....	5 p.p.m.
Arsine.....	1 p.p.m.
Benzene (Benzol).....	100 p.p.m.
Butyl acetate.....	400 p.p.m.†
Butyl alcohol.....	200 p.p.m.†
Carbon dioxide.....	5000 p.p.m.
Carbon disulfide.....	20 p.p.m.
Carbon monoxide.....	100 p.p.m.
Carbon tetrachloride.....	100 p.p.m.
Dichlorobenzene.....	75 p.p.m.
Dimethylaniline.....	similar to aniline
Ethylene dichloride.....	100 p.p.m.
Gasoline (Petroleum).....	1000 p.p.m.
Hydrogen chloride.....	10 p.p.m.
Hydrogen cyanide.....	20 p.p.m.
Hydrogen fluoride.....	3 p.p.m.
Hydrogen sulfide.....	20 p.p.m.
Methyl alcohol.....	200 p.p.m.
Monochlorobenzene.....	75 p.p.m.
Mononitrotoluene.....	similar to nitrobenzene
Nitrobenzene.....	5 p.p.m.
Nitrogen oxides.....	25 p.p.m.
Petroleum naphthas.....	1000 p.p.m.
Phosgene.....	1 p.p.m.
Phosphine.....	1 p.p.m.
Sulfur dioxide.....	10 p.p.m.
Tetrachloroethane.....	10 p.p.m.
Tetrachloroethylene.....	200 p.p.m.
Toluene (Toluol).....	200 p.p.m.
Trichlorethylene.....	200 p.p.m.
Turpentine.....	200 p.p.m.
Xylene (Xylol).....	200 p.p.m.
Barium peroxide.....	0.5 mg./m. ³ ‡
Cadmium.....	0.1 mg./m. ³
Chromic acid.....	0.1 mg./m. ³
Lead.....	0.15 mg./m. ³
Mercury.....	0.1 mg./m. ³
Dinitrotoluene.....	similar to TNT
Tetryl.....	1.5 mg./m. ³ ‡
TNT.....	1.5 mg./m. ³
Zinc oxides.....	15.0 mg./m. ³

Silica (SiO₂) (free or uncombined)..... 5 m.p.p.c.f.

* The maximum allowable concentration for the various substances listed are the values most widely accepted today and are based on an eight-hour daily exposure.

† These values have not been definitely established but are included to serve as a guide.

‡ No specific information available, but believed to present no health hazard at this concentration.

Note: p.p.m. = Parts of substance per million parts of air by volume.

mg./m.³ = Milligrams of substance per cubic meter of air.

m.p.p.c.f. = Millions of particles of substance per cubic foot of air.

TABLE OF TOXIC LIMITS

From time to time, it is necessary for industry to change from one material or substance to another for one of several reasons, such as scarcity of materials, improvement of product, change in process, or reduction in the health hazard. When this becomes necessary, it is important that a substance be selected which is less toxic than the former substance. Whereas the relative toxicity of many materials is unknown at present, there is presented in Table 3 a list of substances and their relative toxicities. This table will be found useful as a guide in the selection of less toxic substitutes.

FIRE HAZARDS OF CERTAIN SOLVENTS

Even though this chapter was written from the industrial hygiene rather than the safety viewpoint, an attempt has been made to avoid the introduction of any fire or explosion hazard in the recommendations for the control of the health hazard. Particularly in those instances where substitution of less toxic solvents has been recommended, consideration was given to the fire and explosion hazard. As a rule, only those solvents having high flash points have been recommended as substitutes for other more toxic solvents, but in several instances where the solvents already in use present fire or explosion hazards other less toxic but similarly flammable solvents have been recommended. Whenever a change in process or the substitution of a material is necessary to reduce the health hazard, consideration must also be given to the control of the fire and explosion hazard. Information on the fire and explosion hazards of various materials is contained in references cited^{19, 20} and additional information may be obtained from the National Fire Protection Association.

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CHAPTER 12

MEDICAL CONTROL OF RESPIRATORY DISEASES

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THE PROBLEM

TODAY, as never before, the comparative lack of specific control measures and the terrific toll of the respiratory diseases—colds, influenza, pneumonia, and tuberculosis—are making rigid demands upon the acumen of every industrial physician, and at the same time cast out a challenge to preventive medicine which cannot be ignored. Fully one-half of the sick absenteeism and over one-third of the work days lost by industrial workers through disability are attributable to respiratory disease. The strategic position of the plant physician for the control of these diseases is not as favorable as it is in the case of such diseases as malaria and syphilis for which specific chemotherapeutic agents are available or in the case of smallpox against which active immunity can be attained.

Workplaces not infrequently provide many of the predisposing factors regarded as significant in respiratory infections. Many workers for the first time in their lives are coming face to face with such conditions as a relatively crowded environment and exposure to gases, fumes, and dust. They must contend with occupational fatigue in becoming hardened to a new form of work. Many are exposed to inclement weather and extreme changes in weather conditions. Malnutrition, allergy, alcoholism, personal handicaps, and other factors contribute to the decreased ability of the individual to resist infection.

It is the purpose of this chapter, first, to review certain measures as they pertain to the control of acute respiratory diseases, and second, to outline similar measures as they apply to tuberculosis and other chronic pulmonary diseases in industry.

ACUTE RESPIRATORY INFECTIONS

The acute respiratory infections are a heterogeneous group of ailments caused by various agents. It is highly probable that many of the so-called colds are caused by filterable viruses. More

than thirty types of pneumococci are involved in pneumococcal pneumonia; more than two types of viruses are known to cause epidemic influenza. The filterable viruses are particularly likely to initiate the disease process. Moreover, it is now recognized that the common pathogens of the respiratory tract participate in the pathogenesis of acute respiratory syndromes. Only too frequently is the common cold followed by such formidable sequelae as pneumonia and tubercul  sis.

Prevalence of Colds

The extensive studies by the U. S. Public Health Service and other organizations have contributed many important facts regarding the common cold. Since it is obviously impossible to present a complete review, only certain etiologic and epidemiologic features will be stressed. The attack rate per person usually averages 2 to 3 per year. Almost all persons are susceptible and very few persons avoid an attack of acute respiratory infection during the course of any one year. Townsend,¹ for instance, stated that in a group followed for 5½ months 90 per cent reported one or more attacks. There is typically, but not always, a period of high prevalence in early spring, a decline in midsummer, another period of high prevalence in autumn, and some decline in December. The peak in the fall of the year is reached with almost explosive suddenness and a high incidence will usually be reported simultaneously in all sections of the country.

Gover, Reed, and Collins,² studying data from students in various universities in the United States over a period of 18 months, concluded that there is "no definite association of respiratory attack rate with marked variations in climate as represented by six American cities with wide geographic and climatic differences."

Other investigators³ have also failed to observe a consistent relation between the incidence of colds and latitude, longitude, and climate.

The above conditions apply to continental United States, but, lest we overlook the infectious nature of colds, the Spitzbergen observations⁴ may be recalled. Spitzbergen is comparatively free of colds in winter, but with the opening of the shipping season about three-fourths of the community's population suffer an attack of the common cold within a week following the arrival of the first ship. Similar observations, as well as clinical and experimental investigations, indicate that the incubation period

for the common cold is probably between 12 and 48 hours or possibly as long as 72 hours.

Cold Vaccine

Prophylactic immunization against the common cold has been tried by means of filterable virus vaccine and by vaccines prepared from mixtures of various pathogens of the respiratory tract. The virus vaccine has had only limited trial and has not proved to be efficacious. According to Dochez,⁵ the future value of common cold virus vaccine is problematical because an attack of cold gives little or no immunity. Bacterial vaccines containing a variety of respiratory pathogens have been used on a wide scale. Many industrial physicians have had first-hand experience with them.⁶ The stock vaccines contain killed pneumococci, *H. influenzae*, *M. catarrhalis*, staphylococci, and streptococci. These organisms tend to be present in the normal nasopharyngeal flora and in case of an attack are assumed to act as secondary invaders. As a result of using such vaccines one would expect a lessening in the harmful effect of these organisms. According to some authorities, these secondary invaders play an important role in a small group of adults who suffer each year from prolonged infections of the upper respiratory tract with such complications as sinusitis and bronchitis. For theoretical reasons, some believe that such vaccines are of considerable value if restricted to that group of individuals in which secondary bacterial infection presumably plays an important part. *The use of these vaccines, however, has not received the endorsement of public health workers, mainly because of lack of scientific proof.*

Influenza Prophylaxis

The etiologic agent of certain epidemics of influenza, as in the instance of the common cold, is a filterable virus. Influenza occurs mainly in a pandemic, an epidemic, or an endemic form.⁸ The cause of pandemic influenza, such as occurred in 1918-1919, is not yet known. In the epidemic form, at least three filterable viruses have been isolated. The cause of endemic influenza, or sporadic gripe is also undetermined. In influenza such organisms as *H. influenzae*, streptococcus, pneumococcus, and *M. catarrhalis* are regarded as secondary invaders which aggravate the pathologic picture by frequently inducing severe and fatal bronchopneumonias. Immunization would be an ideal method of prevention, but no efficacious procedure has been available in past

epidemics, probably as the cause had not been fully determined. "Individual immunity to the virus of influenza as measured by the development of neutralizing antibodies in the blood can be readily accomplished by inoculation of human beings with either living or killed cultures of influenza virus."⁵ Extensive studies are now being carried out with different antigenic strains of the virus. A flu-distemper viral vaccine has been used recently.⁷ Horsfall⁸ in his recent review, however, concludes that the average extent of immunity induced by vaccines containing influenza A virus was too insufficient to allow it to be considered as a practicable prophylactic measure.

Pneumonia Prophylaxis

Artificial immunization against lobar pneumonia, whether active or passive, is of questionable value for prevention. It is known that immunity develops to pneumococci, but the duration of the immunity thus induced is limited.

Environmental Control

Besides control along immunologic lines, measures directed at environment have recently been receiving increased attention. The new "air-borne" or indirect hypothesis "postulates that the greatest spread of respiratory infection is produced by small dried droplets floating in air for relatively long times and distances or by the resuspension of dried droplets in air after they have settled to surfaces such as floors, clothing, and bed clothes."⁹ Alpha hemolytic streptococci of nasopharyngeal origin are widely distributed. The virulence of the microorganism is never more than slightly impaired by sojourn in rooms. One of the outgrowths of these observations as related to surgery is that it has been possible to reduce wound infections by less frequent dressings.

The object in environmental control is to destroy the respiratory pathogens in air either by radiation, or by chemical sprays or aerosols. It has been observed that the concentration of organisms in the air is reduced by natural sunlight; even diffuse daylight has been found to have a lethal effect. These observations suggest planning for maximum window space in occupied buildings.

Ultraviolet radiation, while more potent than visible light, cannot, at present, be unreservedly endorsed for use in industrial plants for the purpose of controlling acute respiratory infections.

If it is used, special attention must be given for protection of individuals, particularly as regards exposure of skin and eyes.

Aerosols.—Various germicides in an appropriate solvent and sometimes incorporating a wetting agent have been used as aerosols. Among the various agents that have been used in experimental work are resorcinol, resorcinol glycerine, hexyl resorcinol in propylene glycol, formaldehyde-water, and hypochlorite solutions. Twort and his coworkers¹⁰ found that 10 per cent hexyl resorcinol dissolved in propylene glycol added to 0.05 per cent sulfonated lorol was the most effective all-around germicidal mixture of those they tested. Minimal effective mist concentration of resorcinol glycerine aerosol was about 1:400,000,000 by volume. This level was confirmed by Williamson and Gotaas.¹¹ The latter, in referring to the practical use of aerosols in places occupied by persons, state that the aerosol must be nontoxic to man, nonirritating to the eyes and lungs, rapidly lethal to the bacteria when present in small concentrations, inodorous, invisible, non-inflammable, noncorrosive, persistent, and should not leave films and coatings on walls and furniture. Needless to say, considerable investigation is necessary before aerosols can be used in occupied rooms. It may be used in such rooms as laboratories and media rooms where the aerial germicide may be allowed to dissipate before the room is occupied.

General Measures in the Control of Colds, Influenza, and Pneumonia

Since no satisfactory immunity can be established against these acute respiratory infections and even the new chemotherapeutic agents are of little avail in viral pneumonias and most other viral diseases, it is apparent that many procedures are necessary to cope with an epidemic of one or all of these diseases. Specific measures of hygiene and sanitation are to be recommended during epidemic periods. Such measures have been tersely summarized for these respiratory diseases, as well as other communicable diseases, in a report of a committee of the American Public Health Association.¹² This pamphlet should be in the hands of every plant medical director.

Because the minor and acute respiratory ailments, such as common cold, not infrequently lead to disabling pneumonia, otitis media, and mastoiditis, a major effort should be directed toward controlling colds. Remembering that colds are spread by close contact in the acute stages of the disease, certain public

health procedures should be seriously considered. These include, among others, (1) isolation at home during the early and highly contagious stage of a cold which will lessen the spread of the infection, and (2) avoidance of close contact with persons suffering from colds, and of closed spaces where large numbers of infected persons congregate, which may be recommended through a health education program.

The spread of these diseases most frequently takes place through the medium of infected particles sprayed into the air by talking, coughing, and sneezing. Where general public health measures for control have been applied, they have included improvement of general hygiene and living conditions, especially overcrowding. Persons suffering from minor respiratory infections should take unusual care in the avoidance of dangerous contacts, allow themselves periods of rest, and avoid such predisposing factors as chilling, exposure to severe climatic changes, fatigue, and excesses of all kinds.

Many procedures in the plant medical department if adopted as routine may aid materially. The preemployment examination should pick out those prone to acute exacerbation, sinusitis, asthma, and bronchitis. Employees should be required to check through the medical department when they become ill on the job and after acute illness. These checks afford an excellent opportunity for directing those ill to prompt treatment by the new therapeutic techniques now available. Contact between persons in the more contagious phases of minor respiratory diseases can therefore be avoided. By thus encouraging prompt treatment, disabling effects may be reduced in number and severity. That an all-around industrial hygiene program will yield substantial results is attested to by a number of recent reports by industrial physicians.

CHRONIC RESPIRATORY INFECTIONS

In addition to the acute respiratory diseases, those of a chronic nature exact a large toll of lost time. These diseases are exemplified by pulmonary tuberculosis, which claims the lives of sixty thousand Americans each year. It is more and more becoming recognized as an affliction of older occupied men.¹³ As an example of American industrial tuberculosis experience, it is gratifying to note that the death rate¹⁴ among industrial policyholders of the Metropolitan Life Insurance Company has been reduced to about one-fifth that of 1917. With the changeover to

war production, however, attention must be directed to a possible increase of this disease, particularly as regards women. The single exception to a satisfactory public health situation in Britain was a rise of almost 10 per cent in the mortality from tuberculosis in 1939 and 1940.¹⁵ The increment in this case was greatest in young women and was thought to be related to malnutrition.

Control Programs

By directing medical measures for the control of the chronic respiratory diseases at pulmonary tuberculosis, tangible results are obtainable with nontuberculous affections as well. The essence of the medical program is the radiographic examination of the chest. This procedure has been the basis of medical control of silicosis, in which disease the infective element, particularly tuberculosis, is the principal cause of disability. As in pneumoconiosis, X-ray examination of the chest, if supplemented by clinical study, will aid in obtaining proper medical management for such other pulmonic conditions as bronchiectasis, asthma, and cancer.

As an illustration of what can be accomplished in tuberculosis control by a plant, reference is made to the experience of Sawyer.^{16, 17} An X-ray survey of 3,280 apparently healthy employees in 1921 showed 2.3 per cent positive for clinical tuberculosis. From 1928 on, the medical department has been doing serial or annual X-rays of the chest. In a group of 4,665 employees, averaging 33 years in age, and studied from 1928 to 1935, only 0.5 per cent showed active or clinical tuberculosis. By 1940 this percentage was down to 0.2 per cent, which is probably close to the irreducible minimum. What has been done by Sawyer can to a considerable extent be achieved in any employed group if a definite program is outlined and followed.

The Metropolitan Life Insurance Company,¹⁸ following the adoption of a tuberculosis control program, reduced the number of cases of significant pulmonary tuberculosis from 40 per 10,000 employees in 1930 to 10 per 10,000 in 1939. Use was made of routine preemployment X-rays and the Metropolitan sanatorium. It was observed, however, that during the period, 1930 to 1939, the prevalence of tuberculosis among applicants for employment had not been reduced; the experience indicates 80 cases of significant tuberculosis per 10,000 applicants and, according to Sherman,¹⁹ this probably represents a fair average.

Other industries also have had anti-tuberculosis programs in effect. There should be no relaxation in the program of controlling pulmonary infection and indeed an extension of the program to the smaller industrial plants is indicated.

X-ray Methods.—Recent radiographic surveys of employed groups, who had not been X-rayed previously, have revealed 1 to 2 per cent of the employees with significant tuberculosis. Case finding is an important feature in a tuberculosis control program that can be effected by the industrial physician. A number of X-ray procedures are available, such as single or stereo 14 by 17 inch films, 14 by 17 inch paper, 35 mm., 4 by 5 inch, or 4 by 10 inch photofluorographic methods, and fluoroscopic examination.

Photofluorograms have been adapted for mass X-raying work in the armed forces, as well as in the medical departments of a number of large industrial plants. If a grid is used, very satisfactory photofluorograms can be obtained. For best results this will require at least 200 milliamperes equipment. It has been the practice not to rely on the fluorograms, particularly the 35 mm. size, for diagnoses, but, instead, this technique is expected to pick out persons with definitely abnormal or suspicious chest findings. These individuals are then rechecked with standard 14 by 17 inch single or stereoroentgenograms taken for diagnostic interpretation.

In advocating small film X-ray pictures as a routine for all patients admitted to general hospitals, Hilleboe²⁰ refers to the experience of the University Hospital, Ann Arbor, Michigan, where it was found by this technique that 10 per cent of the patients admitted showed lesions of the organs in the chest. The U. S. Public Health Service now has eleven photofluorographic units in the field, each accompanied by a medical officer, technician, and clerk. Plants may appeal to the Public Health Service through the State health department for the services of one of these 35 mm. units if no other means for mass X-raying is available. Experience has shown that 300 to 500 photofluorograms a day can be made with one of the units.

Administrative Procedures.—Sawyer,^{16, 17} who has had years of experience administering a tuberculosis control program, offers helpful suggestions in its conduct. His program is directed at three groups: (1) applicants for employment, (2) employees with negative X-rays, and (3) employees with suspected tuberculosis. He has noted that it has been too time-consuming to furnish each individual a report on the findings yielded by his radiogram. Hence, he recommends issuing a mimeographed statement

to the patient at the time of X-ray, stating that if his X-ray is negative he will not receive a report, but if his lungs are affected he will be so notified. Employees having latent, clinically insignificant lesions are reported as having lungs that are negative or clear.

Employability.—Applicants with healed primary tuberculosis or inactive types of reinfection tuberculosis are ordinarily acceptable for employment. For a number of years the Public Health Service has advocated, even in the dusty trades, that the worker with evidence of healed primary tuberculosis should not be denied employment on this account alone. There are many types of employment where persons are acceptable with clinically negative, stabilized lesions, minimal or moderately advanced in extent. If adequate X-ray equipment is available, it may be possible in some instances to accept individuals with small soft lesions, but these workers will require close medical supervision. The individuals with active and questionably active tuberculosis are not acceptable for employment, but should be referred to their physician, the local public health authorities, or a clinic.

Frequency of Periodic X-Ray.—The means toward the end of obtaining satisfactory periodic X-rays is an adequate record system. This will make it possible to call back the employee for reexamination, according to the need for recheck. The Public Health Service has recommended annual medical examination of workers in the siliceous dusty trades to detect evidence of pulmonary tuberculosis and early silicotic changes. Sawyer²¹ recommends annual X-ray for young workers (ages 18 to 25), whose preemployment X-ray was negative for clinical tuberculosis, gradually increasing the time interval between examinations to three years if the chest roentgenogram continues to be negative. Individuals 30 years of age and over with negative X-rays at the beginning of employment are scheduled for re-X-ray at 3-year intervals.

The frequency of X-raying workers with evidence of tuberculosis depends on the extent of pulmonary involvement and dynamic status of the disease. Sherman,¹⁹ in the instance of ex-patients, has suggested X-ray and sputum study every three months for the first two years following their discharge from a sanatorium, and every six months thereafter. He feels that those with a history of contact should be X-rayed at once and every six months for a period of three years and annually thereafter.

Follow-Up, After-Care, Rehabilitation.—Next to finding the case of tuberculosis, adequate follow-up is of extreme importance,

particularly from the patient's standpoint. The patient should be referred to his private physician or to a clinic and the case reported to the local health department. Public health officials and local voluntary tuberculosis agencies are especially helpful in this follow-up stage. They can assist in arranging for sanatorial care and be of material assistance in checking on possible contacts in the home. If sanatoria are not available, outpatient supervision is far superior to no care at all.

In the development and the successful prosecution of a tuberculosis control program in any community, it is essential for public health officers to have the cooperation of the State and local medical society, management, labor, and voluntary agencies. This procedure will insure appropriate follow-up and after-care, and also pave the way for rehabilitation of the affected individual to industry. In this connection, from 65 to 75 per cent of the workers with minimal and moderately advanced tuberculosis¹⁹ can be expected to return to their former positions in industry after an adequate stay in a modern sanatorium. Many industrial organizations reemploy workers with arrested tuberculosis. Factors to be considered in the employment of a worker with arrested tuberculosis are as follows:¹⁷ (1) extent of the lesion, (2) completeness of the cure, (3) character of the job, and (4) the necessity for adequate medical supervision after return to work.

CONCLUSION

In this period of profound socio-economic stress every facility for searching out active cases and getting them under treatment should be employed to prevent an unfavorable effect on the present downward trend of the American tuberculosis mortality rate. The X-ray is a potent tool to this end and the medical departments of many industrial organizations have demonstrated how much can be done in promoting the control of tuberculosis. The plant physician should formulate a program making use of the X-ray for preemployment and periodic examinations of his employees. To provide for satisfactory disposition of cases found, the plant physician should also establish liaison with local workers in the field of tuberculosis control.

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CHAPTER 13

VENEREAL DISEASE CONTROL

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WITHIN the past few years considerable interest in the control of venereal diseases among workers in industry has developed. The cause, spread, and cure of these diseases, as well as their hazards to the patient—particularly mental and physical failure in late syphilis—have long been understood by the medical profession. Active interest in the control of the venereal diseases was not forthcoming until 1936, when a public informational program was inaugurated by physicians, health officers, and public educators. The passage of the Venereal Disease Control Act by the United States Congress in 1938 furnished the necessary impetus and provisions with which to launch a nationwide control program.

Because of the public's acceptance of the venereal disease program, effective measures for the control of syphilis and gonorrhea are now being applied in every State in the Nation. Medical research in this field has been revitalized and is furnishing us with improved methods for diagnosis and more effective therapeutic procedure.

As the nationwide program has progressed, ways and means have been sought for making it more complete and effective. A large group in our population is composed of workers in industry. They represent a compact, homogeneous group for which no specific provisions have as yet been made.* The health of the American worker has assumed a new public significance within the past few years. Manpower at work is wealth. Consequently the worker must be given the opportunity to share in the health benefits of the National venereal disease control program.

Prevalence of the Venereal Diseases

In the United States, syphilis is the *most prevalent of the major communicable diseases*. As the result of an agreement

* On August 10, 1942, recommendations were formulated by the Advisory Committee to the U. S. Public Health Service on the Control of Venereal Diseases in Industry.

between the U. S. Public Health Service and the Selective Service System, it has been possible to obtain information about the prevalence of syphilis among a million Selectees and volunteers between the ages of 21 and 35. Of this number, almost 60,000 were found to have a venereal disease. The prevalence rate for syphilis was 45.2 per thousand and for gonorrhea, 11.5 per thousand.

Based on this information, it is estimated that there are 3,200,000 persons infected with syphilis in the United States—a ratio of one infected person to every 42 in the entire population. An application of the prevalence rates obtained from Selective Service examinations to the general population gives a rate of 24 per thousand for the entire country. Computed by race among the general population, the rates are 13 per thousand for whites and 119 per thousand for Negroes.

In considering the *regional distribution* of syphilis in the United States, it is interesting to note that in sixteen southern States and the District of Columbia, the rate was 46 per thousand, while for the thirty-two northern States, the rate was 14 per thousand.

Reliable figures are not available for gonorrhea because of poor reporting by medical sources, and because of widespread self treatment on the advice of drug clerks. However, it may be said that gonorrhea is two to four times as prevalent as syphilis.

The prevalence of venereal diseases in an industrial population will conform generally to the prevalence rate of the community in which the industry is located and will vary from one community to another. A recent review of serologic surveys of syphilis in industry showed positive rates ranging from a low of one-half per cent to a high of 10.5 per cent, with an average of about 3 per cent.

Workers in Industry

Workers in industry account for a large portion of the total population.

The 1940 census lists a total labor force of some 53,000,000 who are 14 years of age or older; of these, approximately 40,000,000 are men and 13,000,000 are women. About 17,000,000 are employed in the mining, construction, manufacturing, transportation, and communications industries. The Bureau of Labor Statistics in March 1942 estimated that there were 8,250,000 working in the shipbuilding, munitions, armament, and construction in-

dustries. The application of relatively uniform venereal disease control measures to this vast labor force would result in a reduction in the spread of venereal diseases and minimize their importance as causes of ill health. A program in industry, therefore, is a very important part of the nationwide effort to control the venereal diseases.

Industry's Stake

Venereal diseases are costly to labor and to the employers of labor.

Industry draws heavily upon our younger generation for its labor force. Approximately 75 per cent of all syphilitic infections are acquired by individuals between the ages of 15 and 35. The course of the disease is long and the progressive pathological changes which occur when adequate treatment is not administered produce degenerative changes which may result in death or disability 10 to 25 years later—during middle life, and not infrequently when the earning capacity of the individual should be greatest. Syphilis offers disability and death to labor. To the employer of labor it offers the costs incident to absenteeism, labor turnover, increased compensation costs, and personnel problems chargeable to ill health and nervous instability.

It is well to recall that the living cost us considerably more than the dead. In State institutions there are about 19,500 cases of paresis all the time. If we apply the conservative figure of a \$1 a day for the care of these cases, the annual cost would be \$6,500,000. It is important to realize that in the past not enough of our medical care has been directed toward the proper treatment of the early stages of syphilis. The cost of treating a case of early syphilis from infection to cure has been variously estimated to be between \$50 and \$600, depending upon whether treatment was provided in public clinics or by specialists. Fifteen per cent of all blindness is due to syphilis. It is estimated conservatively that we spend \$10,000,000 every year for the institutional care of our syphilitic blind.

Just as all syphilitics are not dead, so all syphilitics are not in institutions or under care at home. Many of them are on their jobs. When they are not receiving medical attention, they represent a potential hazard which carries with it the threat of damage—damage to themselves, damage to their fellow workers, damage to machinery, damage to the general public. The worker with syphilis who is receiving or has already received adequate

treatment does not represent such a hazard, nor is he necessarily less efficient because of his syphilis.

It is pertinent to state at this point that the industrial physician or employer should not utilize reports of employee laboratory tests and physical examinations for the purpose of discharging those who may be found to have syphilis. A policy which discriminates against employment of such persons is no solution to the problem. Industry is a part of community enterprise and its workers a part of the community population. Mutually beneficial objectives can be attained for both employer and employee by the inauguration of a sound venereal disease control program.

Further Justification and Need for a Program

In the past decade, scientific opinion has crystallized with regard to the treatment of syphilis, and within the past few years more effective means have been developed for the treatment of gonorrhea. We have been made aware of the widespread prevalence of these two diseases but the economic loss for which they are responsible has not been fully appreciated.

The average worker loses nine days a year because of illness—eight days for men and 12 for women. The venereal diseases account for their proportionate share of this tremendous waste of manpower. It is particularly important in these times when our country has been forced to assume the responsibility of acting as “the arsenal for democracy” that every effort be brought to bear in reducing the amount of time lost from productive work. The medical profession must assume the responsibility for applying all known diagnostic and treatment procedures to the reduction of those diseases which submit to effective medical management.

The problem of controlling venereal diseases represents one part of an over-all industrial health program. It is important to realize that approximately 85 per cent of the workers are employed in small plants in which there is no organized medical service. Obviously if we are to provide health benefits for the majority of workers it is necessary that industrial medical services be supplied in small plants.

At this time, unfortunately, venereal disease control programs in some industries are impeding the war effort by causing the rejection of available manpower. It is common knowledge that many grave injustices have resulted from routine blood-testing

programs for syphilis in industry. Blood testing is an important case-finding measure in a control program; but short-sighted employment practices in many instances have allowed the results of blood tests to be used as a basis for unfair discrimination against persons found to be infected. The consequence has been loss of work for the employees and loss of their services to the employer. A number of industries, however, have adopted venereal disease control programs and are employing infected persons. These workers have been employed under conditions that have proved satisfactory to the employer as well as to themselves. Obviously, employment policies have not been clearly defined; and there is, therefore, an urgent need for a reexamination of the problem of venereal disease among workers in industry and for the development of a program which will include equitable employment practices.

The Surgeon General recently appointed an Advisory Committee to the U. S. Public Health Service and charged it with the responsibility of recommending a program for the control of venereal diseases in industry. This committee met on August 10, 1942, and drafted its recommendations.

Objectives of a Program in Industry.

From the standpoint of public health, the main objective is case-finding and the referral for proper medical management of all cases of venereal disease among workers in industry. To bring this about, laboratory tests for syphilis and gonorrhea should be added as a routine procedure to all employment examinations. Proper medical management will accomplish the following: (1) prevent the spread of venereal diseases through early and adequate treatment; (2) prevent the development of late disabling manifestations by arresting progress of the disease through adequate treatment; (3) assure adequate treatment by requiring that employment be made dependent on the presentation of satisfactory evidence by the employee that he is under proper medical management; and (4) bring contacts of infectious workers under medical observation.

The objectives of the program from the standpoint of *industry* are: (1) to reduce compensation costs; (2) to lessen work interruptions and labor turnover; (3) to increase production by increasing the efficiency of workers; and (4) to minimize those personnel problems which arise from syphilis and gonorrhea as causes of ill health and nervous instability.

The objectives as regards the *employee* are: (1) to improve the physical condition of employees; (2) to reduce the number of work days lost through illness or injury; (3) to utilize job placement in order that individuals who have a venereal disease may be placed in positions which they are physically capable of performing with profit to themselves and their employer, and without risk to themselves, their fellow workers, or the public; and (4) to prolong and increase the earning power of employees by increasing life expectancy.

Developing a Program

Inasmuch as conditions will vary in communities where industries may be located, methods that will be employed in carrying out a program must be adjusted to meet the local situation. Consideration should be given to the services and facilities that may be furnished by State and local health departments, as well as the size and number of industries in the area concerned.

Agency Cooperation.—It is important that all agencies concerned with the fundamental policies of the program be informed regarding the scope of activities and the methods to be employed. In order that such an understanding be achieved, it is recommended that State health officials charged with the responsibility of the venereal disease control program for industry discuss their plans with the following State-wide agencies: (1) the State labor department, industrial commission or similar department of State government; (2) the industrial health, venereal disease or other appropriate committees of the State medical society; (3) the organizations that represent employers; (4) the labor organizations; and (5) the appropriate voluntary health and welfare associations.

These agencies can render valuable service to the State health department. They can assist in developing certain features of the program, endorse plans, and disseminate through their membership favorable comments. It is suggested that an advisory committee composed of selected representatives from the above-mentioned agencies be formed to give continuity to the State-wide program.

Plant Committee.—It may also be beneficial in the development of plant programs to encourage the organization of a plant committee composed of competent representatives from management, labor and the industrial medical service. Through such a committee, opportunities might be provided for employees to

learn of the need for and value of venereal disease control. The committee might also explain to their fellow workers the question of voluntary or compulsory participation, the confidential nature of all records, the effect on applicants for new positions, and the status of present employees. The extent of industry's responsibility would likewise be made known. This manner of approach will foster amicable relationships within the industrial organization itself, and contribute to the success of the program.

Correlation of Industrial and Community Programs

State and local health departments have been made responsible for the community venereal disease control program. It therefore devolves upon these health authorities to provide for industry certain fundamental services and facilities which have already been developed for the community as a whole. Arrangements can be made when necessary for free laboratory service (including serologic tests for syphilis), treatment facilities, free drugs, speakers and educational material, and case-finding and case-holding services.

Industry should employ without discrimination venereally infected workers, providing that their employment be made dependent upon taking such treatment as may be indicated. This, in itself, is an effective case-holding measure.

Full-time or part-time medical services are available to workers in many plants. An expansion of the industrial medical program to include venereal disease control measures is a logical procedure. For no other serious disease has medical science developed more satisfactory diagnostic treatment and control procedures than for gonorrhea and syphilis. The position of the industrial physician in a venereal disease control program is unique. Because of his position he has the confidence and co-operation of the worker, management, private physician, and health authorities. In a properly conducted program, this association will bring these groups closer together, promote amicable relationships, and provide for a better understanding of mutual problems. Industry and health authorities are individually responsible for their own control programs but because of the inter-relationships of such programs, they have a joint responsibility as well. Industry occupies a position which enables it to develop procedures and policies that can benefit workers as well as its own interests. Public health authorities have established certain services and facilities which, if made available to indus-

try, will materially assist in furthering the success of a program in industry.

Administration of the Program

The venereal disease and industrial hygiene divisions of the State health department are well equipped to assume joint responsibility for administration of the program; to assure success, close cooperation between these two divisions is imperative.

The *industrial hygiene division* of the State health department is familiar with the type and location of industries in the State, the number of persons employed, and the relationship of labor organizations. The *venereal disease division* is familiar with those basic considerations in the general venereal disease control program that will be required for a program in industry. The industrial hygiene division should assume an active role in the preliminary phase of the program. Subsequently, this division can render valuable assistance in persuading plants to adopt suitable control measures. This may be accomplished as a part of the division's regular activities concerned with special studies, surveys, and other contacts with industry.

A *consultation service to industry* should be furnished by the venereal disease division. It should provide detailed information on the inauguration of programs in plants. The information should include recommendations for specific control measures, diagnostic laboratory procedures, treatment facilities, educational material, epidemiologic and case-holding services, and free drug service.

Educational Program

It is important to the success of a program in industry that an educational program precede and accompany the inauguration of venereal disease control measures. Inasmuch as the plant population is a compact, well-organized group, the method of disseminating information can be direct and should not present unusual difficulties.

Employees should be given a general understanding of the venereal diseases. It is desirable also that they be informed of the individual health benefits that will result from venereal disease control, as well as the effect it will have upon their ability to earn a living. Information regarding prophylaxis should be furnished.

Educational effort should be directed at the employer, as well as the employee. He must be made to realize that under proper medical care, nearly all workers suffering from a venereal disease may be employed safely and profitably.

The educational program should be well organized. It should neglect none of the conventional approaches, and should make use of such communication media as pamphlets, posters, folders, articles for publication in management and employee magazines, and, in addition, the presentation of the subject by speakers and motion pictures. Wall racks located in places frequented by workers are considered well adapted to the purpose of distributing pamphlets and folders. Posters may be effectively displayed on bulletin boards located in plants, in union meeting rooms, and in other places where employee meetings are held.

Small groups in a plant population, such as foremen and shop stewards, may be selected for intensive education. In turn, these groups, because of the positions they occupy in the plant, could be expected to relay pertinent information to the total employee population. Thus, the educational program will receive the benefit of person-to-person communication. Accuracy can be achieved by distribution of supporting literature. Most health departments can supply motion-picture films, literature, and posters, as well as personnel familiar with educational techniques.

Examination Results Confidential

It is of utmost importance to the success of the venereal disease control program that the results of the medical examination be kept confidential. Ordinarily, information should be furnished only with the consent of the individual concerned or upon legal advice. Exceptions are the source of medical care to which the worker may be referred for further examination and treatment and the health department.

The industrial physician is charged with the responsibility of safeguarding the interest of his employer, the employee, and the public. To fulfill properly his obligations, he is required to make suitable recommendations to management concerning the physical fitness of employees for work. Such recommendations do not require detailed medical information.

It is the practice in some industrial medical services to make the medical record a part of the general personnel records which are kept in an open file available to nonmedical personnel. Medi-

cal records should be filed in the medical department for the use of the medical staff only.

Employment Policy

Many industries have denied employment or have discharged workers because the physical examination revealed evidence of a venereal disease. Such action demonstrates a complete lack of understanding. The worker with a venereal disease is no different from any other person who requires an income to pay for necessary medical attention. He is definitely in need of friendly medical advice and counsel.

The following considerations should decide the status of employees found to be infected with a venereal disease: (1) the employee should agree to take such treatment as may be indicated; (2) whenever the stage of the disease is infectious, employment should be delayed or interrupted until such time as a temporary non-infectious state is established through treatment; (3) when syphilis exists in a latent stage, employment should not be delayed or interrupted; (4) when disabling manifestations exist which render such persons industrial hazards to themselves, other employees, or to the public, employment may be deferred or denied; (5) provision should be made whenever possible for occupational readjustments of employees who develop disabling manifestations that do not incapacitate them from performing some useful type of work; (6) workers with syphilis in any of its stages and regardless of past or present treatment status should not be employed in areas of toxic exposure; and (7) workers with gonorrhea receiving treatment with a sulfonamide drug should not be employed unless they are under special medical observation.

Employment Examination

Medical supervision of workers should include a careful history, physical examination, such special examinations as may be indicated, and laboratory tests. Serodagnostic tests for syphilis and, when indicated, smears or cultures for gonorrhea, should also be included. Preemployment examination should be required for all workers if the venereal disease control program is to be effective.

Periodic physical examinations for employees are provided by many industries. The interval between these examinations varies

according to the nature of the employee's activities. It should not, however, exceed three years.

Conference with the Industrial Physician

A number of industrial physicians provide an opportunity for the worker with a venereal disease to discuss his problem with them. This practice should be adopted by all industrial physicians. It will serve to orient the worker in regard to his condition and will also enable him to carry out more intelligently his agreement to place himself under proper medical management.

When a worker is found to have a venereal disease that is infectious, he should be referred to a competent physician or to a public clinic (in accordance with his means) for further examination and such treatment as may be indicated.

An applicant who is found to have an infectious venereal disease should be advised that he is, for the time being, ineligible for employment; and that employment must be deferred until such time as he has received sufficient treatment to render him temporarily noninfectious. The employee under similar circumstances should have his employment interrupted until he has complied with the same requirements. Both the applicant and the employee should have explained to them that future employment is dependent upon their willingness to continue under medical supervision until sufficient treatment has been administered to arrest the progress of the disease or effect a "cure."

The applicant or employee whose examination reveals evidence of latent syphilis may be employed without delay, providing he agrees to take such treatment as may be indicated and continues under proper medical supervision.

The question of employing or retaining the services of a worker whose examination reveals evidence of late syphilis with visceral, cardiovascular or neurosyphilitic manifestations, is dependent upon further examination. Important in this decision will be the extent to which the pathological changes have progressed, the availability of a job that the worker is physically capable of performing, and the question of industrial hazard.

It is incumbent upon the industrial physician to recommend the worker to competent sources for medical care. In the event such medical services are not available in the community, industry may well consider the advisability of undertaking to provide this service at a nominal cost to the worker.

Follow-Up

In order to obtain proper consideration from the medical source to which a worker with a venereal disease is referred, it is necessary that a letter describing the circumstances of the examination performed by the industrial physician be furnished. The private physician or the clinic requires a knowledge of the examination results and what is to be expected of the worker by his employer as regards regularity and standards of treatment.

Workers who are employed upon the provision that they submit to such medical supervision should furnish at weekly or monthly intervals a record of their treatment to the industrial medical service. This should be executed by the employee's physician.

Whenever the worker becomes delinquent in treatment without just and sufficient cause and whenever he refuses to continue appropriate treatment, the industrial physician should notify his employer that the employee is no longer fit for work. Such failure on the part of the employee to cooperate justifies his employer in discharging him without further consideration. The names of such individuals should be referred to the health department for appropriate action in returning them to treatment.

Morbidity Reporting

It is the responsibility of the treatment source to report all patients with a venereal disease on appropriate forms to the State or local health department. Case reporting, therefore, is not considered the responsibility of the industrial physician who is engaged primarily in a program of case finding and referral. When treatment is provided by the industrial medical service, however, the responsibility for such reporting obviously rests with the medical service.

In most instances the private physician or venereal disease clinic submits case reports to the State or local health department. However, in view of the urgent necessity for placing infectious cases of syphilis and gonorrhea promptly under medical control, the industrial physician making a tentative diagnosis of communicable syphilis or gonorrhea should acquaint the appropriate health authority with the facts without delay.

Conclusion

The conquest of venereal diseases has been for the past several years one of the main objectives of public health. An exten-

sion of the benefits of the nationwide program should be made available to industry as rapidly as efficient management will permit. The future of industrial medicine is vitally concerned with the nonoccupational disease problem of which syphilis and gonorrhea represent a significant part. Industry is ever seeking to improve its efficiency in order that production may be increased and costs intelligently reduced. The worker desires a profitable remuneration for his efforts, and to assure this his health must be maintained. It therefore becomes obvious that the worker, the employer, the medical profession and public health authorities have many interests in common; and the sooner these interests are properly coordinated, the sooner will we collectively and individually receive health benefits which can be translated into improved economic conditions and a healthier people.

CHAPTER 14

INDUSTRIAL PSYCHIATRY

Lydia G. Giberson, M.D.

PRESIDENT ROOSEVELT'S speech at Bethesda, Maryland, dedicating the new naval hospital, contained one paragraph, which, while applied to the armed forces, might well be taken as a text for every industrial worker in the land, as well as those to whom their medical care is entrusted. He said:

"Such warfare requires men of extraordinary physical alertness as well as exceptional daring. A split second lost in timing by one individual may cost innumerable lives. Therefore, it is not enough for the doctor to work out new methods and cure. He must work out entirely new methods of preparing men for unprecedented combat conditions in submarines, planes and tanks."

The applicability of this condition to the industrial war worker is tremendously striking. The split second in timing may not cost lives but will cost production and often cause injury. The unprecedented strains of war production exact their additional toll of physical and mental alertness.

But most striking is his phrase: "He [the doctor] must work out new methods of preparing men . . ."

I think we may take it as implicit that the President meant preparation mentally as well as physically. The comparison holds even more strongly for the war worker who has not the military training nor exaltation of combat to uphold him. His is the monotony of repeated operation, greatly multiplied under the stress of wartime demands.

A barrage of appeals to the worker's patriotism is all very well as far as it goes, providing a slim substitute for the brute conditions of battle which carry with them their stark element of self-preservation. But the fact remains that, war or no war, the worker lives with the humdrum conditions of his peacetime life and occupation, with the sole exception that he is probably getting better and surer wages and is working quite some harder to make them.

These conditions I emphasize, because they are part of the work-a-day life of the war worker and form his war pattern except that they are underlined and brought into relief along with such war neuroses and strain as he may suffer.

A war does not remove from the worker his anxiety concerning debt. It does not assuage his worry over illness in the home. It does not take away domestic maladjustments.

All these and other familiar ghosts are there to haunt him together with the increased pressure of wartime industrial demands. I recite these homely vicissitudes because they are part and parcel of the lives which drift by the industrial psychiatrist's office in peacetime.

The degree to which this peacetime picture is aggravated by war conditions is, of course, impossible to estimate but certainly an increased tension is there, if nothing else, by the route of increased fatigue.

Psychiatry as it applies to industry, therefore, can only increase its vigilance, according to old familiar signposts, and guard against complete breakdowns within its preventive medical function.

Unfortunately the organized services of industrial psychiatry have not been so formalized in America as to be promptly mobilized for the present need. Comparatively little attention, in fact, has been paid to the mental health of the worker, despite the brilliant work that has been done in industrial medicine, both preventive and therapeutic.

It is upon this splendid organization that there rests some hope of erecting a psychiatric structure which may bear real results in the war effort. Of course, this will demand of the industrial physician, already taxed to the limit, the willingness to train himself and undertake this additional phase of a job.

One of the cardinal factors overlooked in the hurly-burly of industrial competition is that the worker, regardless of mass effort or organization, will inevitably remain an individual and maintain his right to the dignity of an individual. This, possibly, is the keystone on which rests industrial psychiatry. Norms are all very well but they are only norms and guiding signs. The individual is the man who counts.

It would be well to remember that all war workers, by the nature of things, are in the process of a profound sociological change, the outcome of which remains in doubt. There is the in-

evitable question: "After the boom, where do we land?" *Uncertainty*, and there is no finer breeder of mental dislocation.

To superimpose on the structure of industrial medicine a psychiatric service, which of necessity is preventive, is not an impossible task. It has been achieved abroad, notably in England, Germany, and Sweden, and has borne striking results during the past harrowing three years.

The difficulty lies in the fact that the industrial physician already overburdened by the increased wartime demands must adapt himself to the additional techniques demanded by such a program. However, I do not believe this is insuperable.

I say that the industrial physician is the logical medium for the administering of a psychiatric program for the simple reason that industrial psychiatry is at best a supplemental service to general industrial health.

The industrial physician first has the basic medical training which is implicit in the actual meaning of psychiatry as a practice. Second, through long years of faithful ministering to the physical ills of the worker and advice concerning his outside medical service, he has already built up a backlog of confidence through his intimate association with employees and their general health problems.

Again, the industrial physician enjoys in the main, the complete confidence of management, his employer, for whom he is doing a day to day specific job. Thus, he is in a position, with the exercise of ordinary tact, to place the psychiatric aspect of the job on a plane of reasonable neutrality.

It is entirely rational to suppose, for instance, that the worker who has come for emergency treatment after repeated minor accidents will respond to the doctor who has treated him and is seeking the psychiatric basis for this accident record.

It is in this type of rapport that any application of mass psychiatry must find its foothold, for, in the final analysis, all psychiatry is founded on confidence in the practitioner.

Obviously, however, industrial psychiatry can never hope to be anything but preventive, and selective—the separating of the sheep from the goats. Actual therapy must remain where it has always been, in the hands of the private practitioner and the institutions, public or private, created for the purpose.

But even in this instance, the industrial physician in his capacity of part-time psychiatrist, can exercise an invaluable func-

tion in seeing that his patients fall into the right hands and that their needs are met as nearly as circumstances permit.

There is little evidence to show that wartime has produced any new types of neuroses, phobias or any of the other labels. There is quite simply the emergence under the increased stress of war strains, the evidence of unstable personalities which would have remained comparatively latent in the times of peace. The increase in these cases of course is the index of the war tensions. People do not change in war. Their personalities simply emerge further under the unnatural strains.

Most American workers have made their adjustments to industrial living, and if their existence is not upset too radically, they will continue to function smoothly and consistently with only normal lapses for illness and age crises. In any large organization, however, there will be at any one time a fairly constant 20 to 25 per cent of the workers who for chronic or temporary causes are unable to bear efficiently the stresses of industrial work. Peacetime experience has shown that the following classification constitutes the psychiatric bulk in industry:

1. True psychotics: rare instances and eliminated at once from the industrial scene.
2. Subnormal mentalities: not numerous and once adjusted to proper work not troublesome.
3. Psychopathic or borderline personalities: difficult to adjust, and once having reached positions of authority hard to detect and very dangerous to morale and efficiency.
4. Neuropsychiatric conditions: alcoholics, syphilitics, epileptics, postencephalitics, preseniles, and so on.
5. Psychoneurotics: more numerous but chiefly of the anxiety states susceptible to treatment.
6. Industrially maladjusted: the largest and most important group with the following subclassifications:
 - (a) Personality clashes and habitual rule infraction.
 - (b) Accident-proneness and habitual absenteeism.
 - (c) Age crises of menopause and gerontology.
 - (d) Development crises of endings, beginnings, lack of promotion, and the thirty-year social hurdle.
 - (e) Rehabilitation cases of convalescent workers and especially of neurosis following accidental injury.
 - (f) Malign environmental factors of anxiety and malnutrition.

- (g) Overstressed emotional compensations for physical defects and dysfunctions.

As has been stated, the psychiatric bulk in industry represents some 20 to 25 per cent of the total employed in any one corporation or industrial unit. This percentage indicates an average influx for a five year interval with allowance for labor turnover; it does not include nonrecurrent previously disposed cases.

These are normal figures; that is, they are those which one would expect in an industry operating under normal conditions and which had not yet applied any full scale psychiatric program. War conditions will do much to increase that estimate, but for immediate purposes it may be assumed that during the next three years *one man out of every five employed in industry would profit from psychiatric guidance and control.*

The industrial physician can *start an effective program at once*, and that without the immediate need of specialized training other than a sympathetic understanding of the new objectives. With his present equipment:

1. He can expect and trace the emotional complications which will come with every injury and illness he treats or advises on. Even a rough record of his findings may provide valuable data for generalizations.
2. He can listen. The therapeutic value of the interview is considerable, and the connection between surface symptoms of seeming irrelevance such as insomnia, "stomach trouble," and vague neuralgias, with serious underlying conditions may be detected in time for remedial action.
3. He can diagnose the industrial trouble spots—foreman, environment, fatigue, group maladjustment—by analyzing and reviewing his cases at regular intervals.
4. He can spot the accident-prone, the accident repeaters.
5. He can recognize the obvious maladjusted types, arrive at a rough classification and dispose of them by advising transfer, outside therapeutic treatment, or education of the employee in simple principles of mental and physical hygiene.
6. He can help prevent maladjustment by exercising actively his advisory function: (a) by repeatedly bringing to the attention of management each proved instance of preventable maladjustments; (b) by encouraging foremen, section heads, and supervisors to come to him for advice and information on employee problems; (c) by

doing all he can to bring the extra-industrial factors to bear upon any interpretation of employee difficulties.

7. He can conserve manpower and uphold morale through fighting to secure medical immunity for the emotionally ill.

However to expand in any degree on the foregoing points, it is essential that the industrial physician be given the help and training of specialists now in the field.

CHAPTER 15

HEALTH EDUCATION

Elizabeth G. Pritchard, A.B.

"You can lead a horse to water but you can't make him drink"—unless he wants to. That paraphrase of an old proverb contains the need and purpose of workers' health education. If the accumulated labors, knowledge, and skills of industrial hygiene are to be used to the fullest extent, the men and women in the plant must *desire health for themselves*, their families, and their co-workers. *Health education should create that desire* and should result in intelligent cooperation with the medical department by the entire personnel. A planned program of health and safety education is, therefore, an integral part of the industrial hygiene service.

The worker needs both *information* and *training* in health matters; he also needs practical plans for his active participation in the program. These educational needs may be met through individual instruction and group activities.

INDIVIDUAL INSTRUCTION

Opportunities

The emergency treatment given by the medical service for injuries and common ailments brings the doctor and nurse into personal contact with a large proportion of the workers over the course of time. These personal contacts offer fruitful opportunities for health education. The service given establishes confidence and opens the way to a discussion of the accident or illness which brought the worker to the dispensary. Advice as to how to meet such a problem in the future is more likely to be acted upon than counsel given at any other time, for pain is a powerful influence on behavior.

It is through the *preplacement* and *periodic examinations*, however, that the broad preventive program takes shape. Especially in wartime, the industrial medical department will give many workers their first complete medical examination. This is an old story to the physicians and nurses, and to patients who

have gone through the experience previously. The procedures are strange and perhaps a little frightening to many people. A simple explanation of the various steps in the examination and their purposes will not only give the patient confidence, but will help the physician in securing the information which only the patient can give him.

Each examination should be followed as soon as possible by a careful interpretation of the findings, and a discussion of his health status with the worker. In the placement of handicapped workers or workers in particularly hazardous jobs, this procedure would no doubt be routine. For the "healthy" worker, it is just as important.

Mr. Edward L. Bernays, Counsel on Public Relations of the New York Academy of Medicine, has given us the reason: "Health gives no sensory perception, sickness usually does. Many people think health is an effortless state we are entitled to, not something difficult to be won by care and work. . . . Basically the problem of health education is bringing people to a sense of reality, having them make sacrifices and preparation today for tomorrow."

The *interpretation and recommendations of a health examination* are the first step toward realizing the goal of health education. The worker already had opinions and attitudes about his health—right or wrong. The physician as health educator can enormously influence future behavior in his handling of the examination. Most people will respond to "good reasons," presented in their way of thinking, better than to "scientific fact" presented in technical terms. Here are some of the "reasons" workers give:

"I feel all right. What I don't know, won't hurt me. Why look for trouble?"

"They say I ought to have my tonsils out, but where am I going to get the dough?"

"It's a phony! Why get examined and give the boss a good excuse for firing me when he wants to?"

"*Why* should I have an X-ray? I never felt better in my life."

"Sure, I've had a headache for a week. A couple of aspirins will fix me up. Why bother the doc?"

"Good reasons" must be substituted.

The physical set-up of the *dispensary* also is a factor in health education. The well-equipped and properly maintained clinic associates health with cleanliness and orderliness, as well as with re-

lief from pain. A few health posters, changed frequently, and a rack of leaflets in the dispensary or the corridor just outside are helpful adjuncts, especially when waiting lines are long. Some clinics with separate waiting rooms have used the radio, or sound-equipment to play music or health dramas.

GROUP ACTIVITIES

In addition to the direct instruction given by the medical and technical staff, group health education activities should be undertaken. Various plans have been put into effect by a number of industries, State industrial hygiene services, and unions. Since relatively little information is available on the effectiveness of these plans, which include compulsory mass meetings, the establishment of health clubs, committees, classes, and other groupings, perhaps the best that can be done at the present time is to enumerate certain principles which are believed to be essential in a well-planned health and safety education program for workers.

Principles

1. *All educational activities related to health and safety should be coordinated in one program and under one leadership.* Interest in health education for industrial workers has increased tremendously since 1940. Many official and nonofficial organizations, as well as labor unions and individual managements, have become imbued with a desire to help win the war by instructing the workers on particular aspects of health and safety. The workers in a given plant are likely to become confused, if not actually irritated and resentful, under a series of intensive "drives" conducted by a variety of interests.

On the other hand, a well-planned health and safety education program would allow proper emphasis upon topics of current interest—such as nutrition, accident prevention, or tuberculosis control—but would also take account of problems specially interesting to the workers, themselves, and of the outstanding causes of disability in the plant, as determined by the industrial hygiene service. Thus, under one leadership, the program would become a part of the plant's own daily life. Health and safety would be permanent goals, not hit-or-miss targets.

2. *The health and safety education program should be carried out by the workers under medical supervision. A plant or a union may have an educational program without ~~full-time medical~~*

service. Either employers or employees may be the spark-plug; but if there is no industrial physician attached to the plant, medical counsel should be sought elsewhere. The State or local health department, the industrial hygiene service of the State, or the State and local medical societies are proper sources. Under war conditions, physicians in industrial, public health, and private practice, may find the time they can give to educational activities greatly curtailed. Nevertheless, the importance of industrial health to the war effort has commanded a greater interest on the part of the profession, and the advice of a qualified physician will certainly be available to representatives of a plant or union who desire help in planning and organizing a health education program.

If the medical department undertakes the organization and operation of the program, *a health committee of workers*, representing the several departments and *chosen by the workers themselves*, should be established to carry out specific activities, such as organizing study groups, mass meetings, and showings of motion pictures. This committee, or subcommittees appointed by it, could also take the responsibility for securing educational materials approved by the medical department, arranging for exhibits, putting up posters, distributing printed materials, and publicity. Other useful activities for such a committee include: the promotion of hospital insurance schemes; recreation programs; liaison with local welfare services; and participation in community health activities.

3. *The health and safety education program should be integrated with the community health program.* Absenteeism is so often caused by sickness in the family, as well as by the worker's disability due to common ailments, that the need for education on community health problems is obvious. The advice of the local health officer should be sought in order that special community problems may have proper representation in the program. The experience of some educators also indicates that better results are obtained when opportunities are given for the worker's family to participate in the program. Whenever possible, and certainly when general health problems are under discussion, arrangements should be made for members of the workers' families to attend.

4. *Participation in group activities for health and safety education should not be compulsory*, except where training of particular groups is essential to safety.

The organization of clubs, classes, committees, study-groups, and mass meetings is a method designed as much to create interest in health and safety as to impart information. At the present time, the demands upon civilians are heavy; moreover, the disruptions of normal life make it necessary for many people to budget time and energy on an entirely different basis. Therefore, compulsory attendance at "health" meetings is likely to defeat the purposes of the program, especially if activities are carried on outside of work hours.

In the long run, a well-conducted health and safety education program will get better results if it grows, by voluntary acceptance, from a small group of recruits.

Some activities should be compulsory for certain groups. For example, first-aid squads, safety committees, and supervisory personnel should have regular meetings, including instruction on health and safety matters.

All new workers should be required to attend *training* classes for instruction on the safety practices in their particular jobs, fire prevention and security practices in the plant, and on the use and care of protective equipment and clothing. These classes should not only cover a clear description of plant regulations, specific safety procedures, and protective equipment, but they should also give the *reasons* for all these measures and allow plenty of time for questioning by the workers. The workers should also be given the opportunity to practice the procedures in the classes, especially the correct way to use and maintain protective equipment.

Re-training of old workers in the above measures is also essential.

CONTENT OF WORKERS' HEALTH EDUCATION PROGRAM

Subject-Matter

The subjects covered in the educational program will, of course, vary from one industrial establishment to the other, and will be influenced by such factors as occupation, age and sex of the workers, and health conditions in the plant and in the community. For the general group activities, certain broad categories of information should be included, namely:

1. Occupational hazards in the industry, and the means employed in the plant to control hazards.
2. Nonoccupational causes of disability and the means to prevent disease or to bring about speedy recovery.

3. Helpful personal practices, such as rest, sleep, posture, recreation, and cleanliness.
4. Nutrition as a means for better health, including choice of foods, family budgeting, and meal planning.
5. The importance of medical care to the individual and the family, not only in time of sickness but for guidance in the promotion of positive health.
6. The public health program in relation to community and individual health.

These categories of subject-matter, of course, can serve only as guides for the selection of particular topics for discussion. Ultimate choices will depend primarily upon the immediate and outstanding health problems among a particular group. Here, those responsible for the program will have to take account of the worker's interest as well as of the problems known to the medical department. In other words, health education should spring from the desires of the workers and the experience of their medical advisers.

It should be remembered, too, that many outside interests will increasingly seek channels for promotional activities among the nation's war workers. Where these activities fit in with the problems and needs of the group, they may be included in the health and safety education program. But pressure "to put on a campaign" for a health measure or device of dubious value should be resisted.

On the other hand, it is possible that the workers may be deeply concerned about problems which seem irrelevant to those responsible for the program. These subjects demand first consideration, for through prompt attention to problems of which the workers are *aware*, no matter how insignificant medically, the program can quickly progress to more serious health hazards of which they are unaware.

Surgeon General Thomas Parran, in a recent informal talk to the supervisors of civilian personnel in the Signal Corps of the Army, made this approach to health education:

Talk about the program with your group, and find out what difficulties are bothering them. It may be that the outstanding complaint, at the moment, is transportation, or waiting in line at the cafeteria, or a shortage of towels in the wash rooms. These may seem a far cry from sickness and health. But it is an old public health rule to tackle first a problem in which the whole community is interested.

I recall my experience as a young health officer during the World War. The small city to which I was assigned had no safe milk supply, and the

infant mortality and typhoid fever rates were very high. I was eager to put milk pasteurization into effect, but found the community apathetic. On the other hand, the whole town was up in arms about the odors from a nearby slaughterhouse. Although the nuisance had no effect upon sickness and death rates, the people felt that their new health officer should do something about it. As it happened, something could be done; and when the nuisance was abated, the entire community was wholeheartedly with me in securing a safe milk supply.

The same method of recruiting support for the health program will work in your department. If any practical solution to problems in which the men and women are deeply concerned, can be brought about through the joint action of the medical service and the administrative staff, the health program will be greatly advanced through ready acceptance of other procedures not so well understood by the employees.

Approach

Whatever subjects are chosen for the health education program, the presentation should be simple, direct, practical, and brief. In the past, the approach to health education of adults has been heavily influenced by scientific and technical terminology. Physicians, health officers, and health educators have addressed their public as though they were medical students, a far cry from the way the family doctor sits down and tells John Doe what ails him and why, and what to do about it.

How to avoid sickness and how to meet emergencies are serious problems for millions of adults, especially at the present time when every effort must be made to conserve our medical resources—our doctors, dentists, nurses, and hospital facilities. A very large majority of the war workers have come out of school with little knowledge of health protection. Their health education comprises the teachings of advertisers and the fatuous theory that by obeying school-book rules of hygiene, one will come unscathed to a ripe old age and die with his boots on.

Learning a few practical facts about the health hazards of adulthood does not involve a detailed course in bacteriology, anatomy, physiology—or any of the “ologies.” Few adults have the time or interest to pursue a premedical course. Hence, health information should be as simple as one of the 1942 job-sheets used in training young workers—with the addition of *reasons* for the facts presented and recommendations made. The presentation also should make practical application of the facts to present conditions, and in such a way as to arouse the worker's interest and help him relate the information to his daily life.

As has been suggested before, health education for workers is under heavy competition with other interests. Not the least

of these is our "ancient enemy"—self-treatment. Undoubtedly, this tendency will increase, both because more people are earning money and because there is a shortage of physicians in many industrial areas.

The reasons for the public's costly reliance on patent remedies, quackery, and self-treatment have not been fully explored. To be sure, they are complex and present many interrelated aspects—economic, sociological, educational, and psychological. It would appear that the educational and psychological aspects of the problem have not been sufficiently well explored, for if all the economic and social problems of medical care were solved tomorrow, the solutions could scarcely function with maximum benefit until the educational and psychological barriers against the use of scientific medicine are also lowered.

Because so many minor ailments "respond" to self-treatment, adults who have not learned to seek good medical care promptly cannot readily be persuaded to turn from old habits of delay and of using home remedies. A health education program for workers should stimulate more attention to this problem.

The patient, as a matter of fact, has to make the first "diagnosis" himself—else he would not present himself to the physician. How, then, can "healthy" people be taught to distinguish fleeting, subjective symptoms from the warning signals of serious illness? Can self-diagnosis be improved? Can this be done without increasing neuroses? These questions should be given serious thought in the development of a workers' health education program.

Adults who have had the best available medical care since childhood, and nothing but the best, have little difficulty in choosing a competent physician. Besides noting such obvious qualifications as graduation from an approved medical school, licensure, and membership in his local medical society, these fortunate men and women unconsciously compare the methods of the chosen practitioner, his personal characteristics, his way of asking and answering questions, his equipment and instruments, with those of other competent physicians who have cared for them and their families in the past.

For many men and women, the difference between an unethical quack who has a dazzling array of gadgets and signboards, and a fumbling, mediocre ethical practitioner in an ill-equipped office is not apparent. Both would be rejected forthwith by an experienced family. The inexperienced worker may accept

either, with odds in favor of the charlatan who "puts on a great show." The health education program should attempt to substitute for lack of experience by guiding the workers in the choice of a physician.

HEALTH EDUCATION MATERIALS

The war has not halted the flood of "health" information to the public. In fact, there appears to be a substantial increase in the output of printed matter, graphic material, motion pictures, radio broadcasts, and newspaper and magazine articles.

A great many of the new materials are excellent, not only in the scientific accuracy of the information provided, but also in the approach and manner of presentation. Perhaps an even greater amount has been prepared by the most diversified sources, with scant attention to medical and public health knowledge and for the purpose of promoting special interests or for personal gain.

All materials presented in the workers' health education program, therefore, should be examined and approved by the medical adviser. This approval would assure the accuracy of the material, prevent confusion, if not misconception in the minds of the workers, and increase confidence in the program. The Public Health Service is prepared to assist in the selection of materials for use in industrial health education programs.

Printed Materials

These include pamphlets, leaflets, reprints, and magazine articles which are most useful as study materials for health clubs, classes, committees and the like. Many health educators favor the distribution of short pamphlets (the leaflet or folder type) at mass meetings, and by mail. With large audiences, it is more economical to distribute the material individually at the close of the meeting rather than to leave stacks of them on a table.

The insertion of "health messages" in pay envelopes is not so effective as direct mail to the worker's home. This can be done as an enclosure with some important communication, like an electric light bill; or, if funds permit, as separate regular mailings to workers who are participating in the program. Direct-by-mail distribution gives the entire family an opportunity to read the material before the worker discards it.

A few copies of health pamphlets may be made available in such places as the dispensary, union halls, recreation centers,

rest rooms, and public libraries. The health committee should be responsible for renewing supplies, checking on the most popular items, and filling requests for new publications.

Physicians and nurses may also find pamphlets useful as a "follow-up" for personal interviews with patients.

Posters

These attract attention, serve as reminders, and are excellent "dressing" for large meetings. Display posters in work shops, rest rooms, wash rooms, hallways, employment offices, union halls, and at mass meetings. Change posters frequently. It is better to show one subject in many different places at the same time than to show several subjects. Posters should be changed at least once a week. The same posters may be shown again at a later time. To keep the poster story fresh, and other displays in circulation, the health committee should assume responsibility for the health education program's visual materials and their effective display.

Photographs have many uses in health education. However, technical pictures are seldom useful and "horror" photographs drawn from clinical files are taboo. When the group is small, and slides or motion pictures cannot be shown, a selection of photos can be used to illustrate a talk. A display of photographs illustrating a particular health and safety goal may be placed at entrance and exit doors, in cafeterias, and in other appropriate places. Displays on the topic to be discussed are good as "dressing" for the meeting hall or speakers platform. Specifications for an inexpensive portable display panel may be obtained from the Public Health Service.

Films

Many good health films, both motion pictures and film-strips, are now available from numerous agencies. In an organized program, arrange for the showing of films on the subjects to be discussed. Select short films, and if the audience is large, show the film at the close of the program. In small groups, the film may become the basis of discussion, and therefore is shown first. If the picture is to be part of a health lecture, the *talk* should be cut short, and time should still be allowed for questions.

Especially with large groups, the health education meeting should be short. Some educators believe that one hour is the maximum for sustained attention and assimilation of important facts.

With a good leader, small discussion groups may wish to continue as long as two hours. Unillustrated talks, even when given by interesting speakers, should not last longer than 15 minutes; discussion during the remaining time will be more fruitful.

Once the general outline of the program has been presented, health education meetings should not attempt to cover more than one topic at a time. New topics will always be introduced during the question period, but discussion of them should be postponed for a future meeting.

CHAPTER 16

INDUSTRIAL FATIGUE: CAUSES AND CONTROL

Robert H. Flinn, M.D.

THE PROBLEM

FATIGUE in industry has always been an important problem in production. During the first World War the need for an inexhaustible supply of war materials greatly aggravated the problem and clearly demonstrated that the wheels of industry were no more efficient than the human factors involved. Excessive sickness and accidents, decreased production, and spoilage of materials called attention to the urgency of this problem and to the need for a careful appraisal of fatigue and its relation to conditions of employment. Consequently, extensive studies were made of fatigue, especially in Great Britain and the United States, and much information has been developed to throw further light upon the subject.

Fortunately, in recent decades, much progress has been made in combating fatigue, partly by the application of known facts concerning its prevention, and to a large extent by technological progress in many industrial operations. Until our entrance into the present war, the tendency had been growing to shorten the working hours, to select the proper worker for the job, to see that each worker learned to do his job skillfully and efficiently, to mechanize operations previously performed by hand, and to take every precaution to make the working environment as free of health and accident hazards as was practicable.

Now that we have entered another war that promises to be the most gigantic and crucial struggle in history, many of the old problems are arising in an exaggerated form. This is particularly true because of the tremendous increase in the use of mechanized methods of warfare and the urgency of the need for immediate mass production. We have begun to produce airplanes, tanks, guns, ships, and explosives on an unprecedented scale and will continue to increase this production as long as necessary. This will result in longer working hours, speed-up in production, night shifts, the use of unskilled and physically in-

ferior workers, many more women in industry, delays in transportation, crowded housing conditions, and restriction in the food supplies and other needs of the workers. All these factors tend to cause unusual strain on the workers, contributing toward fatigue and often resulting in impaired health. To keep those workers efficient and on the job full time, every tool of modern industrial hygiene practice must be known and be utilized.

WHAT IS FATIGUE?

Fatigue has been defined in many ways by different investigators, as may be seen by reading the reports on numerous studies. This variation may be ascribed in part to the different lines of attack on the problem, the varying background of the investigators, and the varying causes, both in *quality* and *quantity*, of fatigue in the persons under investigation. For example, a physiological appraisal of an athlete who has just completed a race would give a wholly different concept than a psychological study of a student who had been employed continuously at mental work for twenty-four hours. Similarly, the statistically-minded investigator would have a different viewpoint after tabulating and analyzing data on the number of pieces of work turned out by different groups of individuals, hour by hour, and day by day, under standard conditions. Other studies have included analyses of accidents, of spoilage of materials, of absenteeism, and of labor turnover as indices of fatigue.

For the sake of simplicity, *industrial fatigue may be thought of as a general physiological state manifested by the impaired ability of the worker to do his job properly owing to unfavorable past experience.* The objective manifestations of fatigue are often, but not necessarily, accompanied by subjective symptoms.

CAUSES OF FATIGUE

This unfavorable experience as the cause of fatigue may have occurred on or off the job, or in both situations. *At work*, it may have included excessive hours of work; excessive speed-up of work; boredom due to repetitive work; awkward work movements; lack of properly spaced rest periods; improper posture; excessive noise; excessive heat; inadequate illumination or glare; noxious dusts, fumes, and gases; inadequate food, water, and salt intake; emotional disturbances caused by fear of not doing the job right or of losing the job; and an improper attitude toward the job.

Off the job factors may have included loss of sleep, intemperance, delays in reaching work, unhealthful living conditions, emotional disturbances about home and family affairs, worry from different causes, lack of outside interests, inadequate nutrition, and illness itself. Of these factors, in recent years *nutrition* has been shown to play an extremely important part in the health and efficiency of the worker. Lack of an adequate intake of vitamins and minerals, in addition to carbohydrate, proteins, and fat, results in a marked reduction of efficiency and well-being. Dissipation likewise aggravates the effects of fatigue and interferes with recuperation, thereby forming a vicious cycle. Several of these factors often are working together to produce impaired functioning of the individual.

Executives, especially, are prone to chronic fatigue caused by self-driving, excessive hours, inability to relax, and nervous tension usually resulting in bolted, inadequate meals and in troubled, restless sleep.

Fatigue is normally physiological and the worker's full vitality may be quickly restored to normal after an adequate period of rest and sleep. *Repeated excessive fatigue* may lead to a state of exhaustion and the worker's full energies will not be recovered by ordinary means. Such a change may progress gradually and imperceptibly over many months. This morbid type of fatigue, if continued, may, and often does, result in permanent impairment of the worker's health and productive capacity as described by Collier.^{3, 4} This chronic, disabling type of fatigue must be especially guarded against in view of the prediction of our leaders that the ability to produce the munitions of war on a sustained scale will in the long run determine the outcome.

MEASUREMENT OF FATIGUE

Measurement of Productive Capacity

As there is at present no precise or accurate single method for detecting or measuring fatigue as discussed by Ivy,¹¹ investigators are restricted in their methods to those measuring impaired functions of the individual or of groups of individuals. One of the most direct methods, of course, when practicable, is to measure the exact productive capacity of workers in relation to their job, decreased productive capacity being considered a manifestation of fatigue. Other factors may be taken into consideration by this method, such as errors or spoilage of materials, absenteeism, and accidental injuries.

Appraisal of Altered Functions

Another approach is to study the individual for evidence of impaired simple functions, either physiological or psychological, and then to try to fit these impaired functions together into a pattern indicating the relative degree of functional efficiency or the fatigue status of the subject. This method is the clinical approach discussed by Collier³ and follows that recently recommended by the Committee on Work in Industry of the National Research Council.¹⁹

This appraisal of altered functions of the worker is analogous to the diagnosis of a disease whose exact cause and nature are unknown, each altered function being considered as a symptom. Before the discovery of the tubercle bacillus, pulmonary tuberculosis was diagnosed by the cough and blood-tinged sputum, the rales and dullness over or under the clavicles, the fever and rapid pulse, the wasting, and the common symptoms of toxemia. Similarly, fatigue might be considered to be indicated by a pattern of impaired functions in the individual, including such relatively simple factors as a delayed response to a stimulus, unsteadiness, decreased coordination, impaired muscular ability, changes in blood chemistry, and eyestrain, as compared to the normal or rested state. Collier has stated in this connection that from a clinical or medical standpoint, *only a narrow margin separates fatigue from disease.*³

A. RECENT STUDY OF FATIGUE

A clinical approach to the study of fatigue was recently made by the U. S. Public Health Service through its Division of Industrial Hygiene of the National Institute of Health.¹² The Interstate Commerce Commission had requested that a study be made of fatigue with relation to hours of driving and other conditions of work among interstate truck drivers in an effort to adduce further evidence to serve as an aid to judgment in setting a proper limitation on the hours of work in the interest of highway safety.

It was apparent from the results of preliminary tests that the altered functions observed in truck drivers following a day at the wheel were not the well-recognized physiological changes commonly observed in workers or athletes after severe muscular exertion. Rather they were more of the *psychological type of alteration* as evidenced by tests of psychomotor or neuromuscular function together with some few slight physiological changes.

Tests Employed

Accordingly, some of these methods were chosen for the intensive testing of commercial truck drivers in the field during their actual work day. The tests selected as of possible value for the field study included a battery of psychological tests designed to measure relatively simple functions; an automobile driving test in an apparatus designed to simulate the driving compartment of an automobile; a visual acuity test; a visual test for measuring critical fusion frequency of flicker; a test of the speed of eye movement by means of the ophthalmograph; white blood cell counts and differential counts; biochemical analyses of the blood for serum potassium and total base; and a complete medical history and examination, including routine clinical laboratory tests on specimens of blood and urine, and two tests for carbon monoxide in blood. The medical examinations were made to appraise the health of this group and to compare it with other industrial groups, to bring clinical data to bear on the problem of fatigue, and to determine if the occupation of truck driving had possibly harmful effects on the drivers' health.

About 900 drivers were examined in 1,200 test sessions in 3 cities. They were tested in a presumably rested state and after drives of varying lengths up to more than 18 hours. Complete occupational, driving, and medical histories were obtained from each driver. As a group, the drivers were found to be in good health, although a fair proportion showed possible evidences of fatigue, such as blood-shot eyes, tremors, reflex changes, and blood pressure alterations.¹²

Results

The results of the various psychological and physiological tests demonstrated that with increasing hours of driving, there was a gradual and progressive diminution in certain bodily functions. The most consistent changes were found in *speed of tapping, reaction time, reaction-coordination time, and manual steadiness*. There was also an increase in *body sway*, which was tested on a limited scale. In addition, there were slight but consistent changes in *vigilance* on the driving test, and in ability to *perceive* a rapidly flickering light.

Other but not altogether consistent changes indicating reduced efficiency were shown by tests of glare resistance, speed of eye movement, accuracy of aiming, steering efficiency, and brake reaction time. The heart rate, blood pressure, and white

cell counts showed variations with hours of driving. There were no changes observed in blood chemistry, urinalyses, differential white cell counts, and certain other functions.

After this pattern was established of altered functions indicating drivers' fatigue, a statistical device was developed by Hammond¹² for assigning a single, composite score to each driver, which averaged his relative deviation on the several tests from the average scores for the rested group. Curves were plotted by this method which indicated a gradual but progressive decrease in average functional efficiency with increasing hours of driving.

In comparing individual drivers, it was found that by setting an arbitrary level of low functional efficiency, only 9 per cent of the men in the rested group fell below this level as compared with 27 per cent, 33 per cent, and 42 per cent of the men in the 1 to 7, 8 to 11, and 12+ hours of driving groups, respectively. It was found that the physician's independent judgment of *apparent fatigue* and the driver's own *estimate of fatigue* correlated well with the composite scores assigned the individuals in all driving groups, thereby substantiating the validity of this method. For various reasons, some drivers showed evidence of fatigue even in the presumably rested group, attributable to outside influences largely. It was believed that the differences demonstrated between the driving groups and rested group would have been greater but for this factor.

After discussing these considerations, the authors concluded: While many factors in the daily lives and background of the drivers may operate to reduce the efficiency, and, therefore, the safety of driving, long hours of driving have been shown to be important in this respect. Furthermore, hours of driving are controllable while many of the other factors are not readily controlled except by the drivers themselves. It would therefore appear that a reasonable limitation of the hours of service would, at the very least, reduce the number of drivers on the road with very low functional efficiency. This, it might reasonably be inferred, would act in the interest of highway safety.¹²

DISCUSSION

It is apparent from the results of the foregoing study that a *pattern of psychological and physiological changes* was established indicating impaired functional efficiency in relatively simple functions that are involved at a high level of complexity in the act of driving. This impaired functioning of the driver was

roughly proportional to the number of hours spent at the wheel since his last period of sleep. This pattern can be interpreted as the syndrome of truck driver's fatigue, so far as tested. Doubtless many other functions are involved that are of importance in appraising the behavior of the whole organism. In many other occupations the pattern of fatigue would be different, as in inspecting, powder weighing, blast furnace tending, or fuse assembling. In each instance, however, one would expect the impairment of certain functions primarily concerned with the occupation, causing a diminished capacity for continuing that occupation until the worker is allowed a period of rest for recovery.

Individual Human Factor in Fatigue

No critical point was found among truck drivers in the hours-of-driving scale in which there was such a sudden change in functional efficiency as to give an obvious figure for the limitation of hours of driving. Such a point could not be expected in view of known individual variation in all biological phenomena. There is a great variation in the individual's ability to compensate for fatigue, in his resistance to deleterious influences, and in his recovery state at the beginning of work. Short of exhaustion, it cannot be expected that there is a dividing line, on one side of which a person is wholly efficient and on the other side wholly inefficient, taking into consideration the complexity of the fatigue pattern for the individual's whole organism, and its gradual alteration. This is true of groups of workers as well as for the individual worker with the added complexity of the variations in different jobs. Differences in attitude and incentive have been shown also to play a large part in maintaining efficiency.²²

Nevertheless, as functional efficiency decreases with increasing hours of driving and usually in other work as well, it is apparent that a reasonable limitation of such hours would decrease the number of unfit workers and the possibility of the ill effects due to excessive fatigue. This has been proved in actual practice by Vernon,²⁶ among others. The exact number of hours of work must necessarily be an administrative decision in which the urgency of the task and need of immediate high production must be balanced against the risk of lowered production in the long run if the human machine is pushed too far.

Optimum Hours of Work for Sustained Production

In a vital emergency of short duration, a great increase in both hours and speed of work will increase production proportionally since most workers will be able to compensate for this situation for a time. In a prolonged war, however, such a productive spurt would be wasteful in that as chronic fatigue is induced among the workers, there would be increasing illness and injuries, and decreasing quantity and quality of production. It would seem desirable, then, to bend every effort to determine the *optimum hours of work* for maximum and prolonged production in our national crisis. It is to be expected that this level would vary somewhat from one industry to another and that considerable study, as well as trial and error, will be necessary to reach an efficient balance.

The British experience devolving from researches into industrial fatigue and efficiency has been outlined in a recent publication by H. M. Vernon.²⁶ He points out that the cardinal error committed by many employers of labor during the last war was the imposition of excessive hours of work. Employees who had been working from forty-eight to fifty-four hours a week were required to work seventy, eighty, and even ninety hours a week in an effort to increase the production of war materials. With these excessive hours of work, investigations showed that because of increasing sickness, accidents, and spoilage of materials, production suffered heavily. Illness was found to be the cause of twice as much lost time among both men and women who worked long hours as among those who worked relatively short hours.

Kossoris, in summarizing the British investigations,¹⁸ showed that men engaged in the heavy manual labor of sizing fuse bodies increased their total weekly production 22 per cent when the weekly hours of work were decreased from 66.7 to 56.6 (15 per cent), these results being obtained over a thirteen-month period. This was attributable to a 39 per cent increase in hourly output and a decrease in wasted time from 8.5 hours per week to 5.3 hours. It was also shown in a ninety-three-week study of 100 experienced female operators on capstan lathes, turning aluminum fuse bodies, that by reducing the weekly hours in the plant from 74.5 to 63.5 there was no decrease in production, and that when the hours of work were further reduced to 55.3 there was a 13 per cent weekly increase in production.

The possible improvement in output during a shorter work

week was found to depend largely on the amount of control the workers had over the speed of production, the improvement being greatest when operations were entirely performed by hand, but improvements in production were found even in operations largely governed by the speed of the machines after reducing excessively long hours of work.

As regards *most suitable maximum hours* of work for sustained production with regard to British experience in the past and present war, Vernon suggests that hours for women be limited somewhere between forty-eight and fifty-four hours a week, and consideration be given to holding to the forty-eight-hour level.²⁶ Young girls of sixteen and seventeen should not be required to work more than forty-eight hours a week. For labor requiring a similar degree of physical effort, he states that men can undoubtedly work longer hours than women, and skilled men such as tool makers and tool setters, whose work is comparatively light physically, can work sixty hours a week without undue fatigue, and probably rather more. For heavy physical work, however, he suggests the work week be limited to forty-eight hours. German researchers have reached similar conclusions.

A recent report from the Industrial Health Research Board¹⁰ gives the results of an investigation made in a number of munitions factories during the period from the outbreak of the present war until the end of June, 1941. This report concludes in part:

1. The results of this inquiry show that the time lost by factory workers through sickness, injury and absence without permission, when undisturbed by extraneous factors, varied with the weekly hours of work. It was usually low when the hours of work were less than 60 per week, but increased as the hours increased up to 75.

2. The findings suggest that, over an extended period, the weekly hours of work should generally not exceed 60 to 65 for men and 55 to 60 for women.

It must be borne in mind that there were variations in living and working conditions between English workers and American workers, including previous customary hours of work, restrictions of diet, and in the working environment. It is a matter of some conjecture, therefore, as to exactly how far these findings apply to the situation in America. Some observers have stated that the American speed of work is somewhat faster than in England.

A recently appointed committee representing eight United States governmental agencies directly concerned with furthering

war production studied all available evidence on hours of work and concluded:

... that for wartime production the 8-hour day and 48-hour week approximate the best working schedule for sustained efficiency in most industrial operations. While hours in excess of 48 per week have proved necessary in some instances due to a limited supply of supervisory and skilled manpower, there has been some tendency to continue longer schedules after sufficient opportunity has been afforded to train additional key employees.

Plants which are now employing individual workers longer than 48 hours a week should carefully analyze their present situation with respect to output and time lost because of absenteeism, accidents, illness, and fatigue. They should reexamine the possibilities of training additional workers now, in order to lessen the need for excessive overtime during the long pull ahead. As rapidly as is feasible these plants should introduce the hours-schedules that will maintain the best possible rate of production for the duration.²¹

This committee also advocated that one scheduled day of rest for the workers and supervisors, approximately every 7 days, should be a universal and invariable rule.

It should also be remembered that in many recently expanded defense areas it takes our workers an hour or more each way to go to and from work, thus effectively adding as much as 12 to 14 hours to their work week. In some instances, this time required for commuting may be as deleterious to the worker's efficiency as additional hours on the job.

Rest Pauses

Vernon also reports that the instituting of short rest pauses during the middle of the morning and afternoon work periods had a tendency to increase production despite the actual time lost. In one investigation there was a 6.2 per cent increase in production from a seven- to ten-minute pause in the work during the morning. The beneficial effects of these rest pauses seemed enhanced by serving light refreshments. This practice is particularly valuable in monotonous, repetitive work. These findings were also confirmed in a five-year study in the Western Electric Company's plant at Hawthorne.^{18, 22} Hamilton⁸ and Collier⁴ have discussed the value of rest pauses and other factors in producing a good attitude among the workers and in preventing fatigue.

Vacations

The importance of vacations spent away from the workshop and home environment is generally recognized in preventing or overcoming chronic fatigue. This is particularly true during the

stress of wartime activities. Many authorities believe that several short vacations are more beneficial than one prolonged annual vacation in promoting employee health and efficiency. The Industrial Health Research Board found that the introduction of weekend breaks, as well as holiday rotation schemes, was followed by lessened absenteeism.¹⁰ The United States Government committee pointed out the value of vacations and recommended that they be staggered over the longest possible period. They also stated that industry must exert the utmost ingenuity to obtain the benefits without paying an overbalancing cost in productive hours lost.

Shift Rotations

In many large American industries working on a 24-hour daily schedule, it is customary to rotate the workers from one shift to another every week or two. Although it is realized that there is much to be said on the question of frequent versus infrequent rotation of shifts, *physiologic considerations* indicate that after a change of shifts many workers require several days to several weeks to readjust their eating, sleeping, leisure, and work habits as shown by the investigations of Kleitman.^{14, 15} Consequently, with a weekly shift rotation, many workers would never become wholly adjusted, resulting in impaired efficiency. Dr. Thomas Parran, Surgeon General of the U. S. Public Health Service, has recommended that shifts should not be rotated more often than every 2 or 3 months. It is realized, of course, that this policy would depend somewhat upon local conditions, but the weekly or biweekly rotation of shifts is to be discouraged.

Kleitman¹⁵ has also suggested that shifts should be timed in such a way as to result in only the minimum displacement of the normal 24-hour cycle of activity. For example, the first shift could begin at noon instead of 8 A. M. Such an arrangement might well result in lessened disturbance of normal family life, and a decreased demand on transportation during rush hours. These and related factors deserve serious consideration.

Diet

Adequate nutrition is of particular importance in preventing excessive fatigue and in maintaining the workers' health. Sebrell²³ points out that as more and more clinical studies are being conducted, we are learning that deficient diets—short of producing the symptoms of a full-blown deficiency disease—may be responsible for such symptoms as mental depression, indigestion, *easy*

fatigue, loss of weight, retarded learning ability, and interference with vision. He quotes the recommendations proposed by the Committee on Food and Nutrition of the National Research Council²⁰ showing that much more food, including vitamins, is needed by active men and women than by inactive persons, and states that at present we have thousands of workers under greater strain and activity than they have undergone for years, with no organized effort to improve their food supply. Many have also moved into new sections not prepared either to feed or to house them properly, in many instances causing their nutritive status to become worse.

The importance of adequate nutrition in maintaining health and efficiency has been emphasized in another section of this manual. Attention is directed, however, to the fact that the Government Committee specified that a 30-minute meal period in mid-shift is desirable for men and women from the standpoint of the workers' health and productivity.²¹

Personnel Policies

A well rounded out personnel policy providing for the social and economic welfare of the workers pays large dividends. Ivy¹¹ has remarked that many things have been found to impair and to improve productivity in factories, but that it appears as if most anything the management does, which attracts the interest of the workers or indicates interest in their welfare, improves productivity. Group life insurance and sickness benefit policies, employment security provisions, personnel counselling, recreational and social programs, credit unions, attention to women's problems, visiting nurses, and other welfare activities improve employee morale. It has been repeatedly demonstrated that a favorable attitude of the worker toward his job and the employer helps to prevent fatigue and increase production.^{19, 22}

Environmental Factors

Many factors in the *working environment* produce and aggravate fatigue, as listed under causes of fatigue. These are discussed in detail in other sections of this manual. Practically all these factors can be removed or controlled by the active and co-ordinated efforts of the medical, safety, and technical personnel working hand in hand with the plant foremen. Sick absenteeism records should be studied to detect environmental or other causes of excessive illness. Especial attention should be paid to good

plant housekeeping, adequate illumination and freedom from glare, and control of air contaminants.

RECOMMENDATIONS

To combat fatigue and its resultant illness and inefficiency and to promote maximum sustained production for the war effort, the following recommendations are made.

At Work

1. Each employee should be *trained* to do his job safely and efficiently. He should know the whys and wherefores of his job and how it fits into the general scheme.
2. Each new employee should be *placed* at a job consistent with his physical and mental capacity.
3. Each job should be *engineered* for maximum efficiency, taking into consideration such factors as posture, awkward movements, illumination, and safety and health hazards. The rules of good plant housekeeping should be enforced at all times.
4. Foremen should take a *kindly interest* in the worker, and make him feel to be an important and integral part of the organization. They should try to prevent friction and antagonism among employees.
5. The usual work week should *not exceed 48 hours* on a 6-day basis. Longer hours for both supervisors and workers should be adjusted downward as soon as new personnel can be trained. Every supervisor and employee should have one day for rest and recreation every week.
6. Activity on production lines should not be *sped up* to the point of inefficiency.
7. At monotonous and repetitive work, 5 minutes might well be allowed every hour for a brief *rest period*. At less intensive work, 10 to 15 minutes' rest in the middle of the first and last halves of the shift will usually prove beneficial. Milk, fruit drinks, and nutritious sandwiches should be available during these pauses.
8. At highly monotonous and exacting tasks, workers should be rotated from one job to another at frequent intervals.
9. Workers required to stand more or less continuously should wear well-fitted and comfortable shoes.
10. Paid *vacations* of one or two weeks, staggered throughout the year, should be the invariable rule.

11. Shifts should be *rotated infrequently*, perhaps every 2 or 3 months instead of every week or two. Nurses assigned to shifts should be changed at the same time as the workers.
12. Medical and nursing care should be available on *all shifts*. Workers with nonoccupational illnesses should be advised concerning the necessity of obtaining adequate medical, dental, and nursing care in order to keep them fit and on the job.
13. Inexpensive and *well-balanced meals* should be available to workers on *all shifts*. Workers should be allowed 30 minutes to wash and eat.
14. Welfare policies should be expanded to include group life, sickness, and hospital insurance, personnel counselling, recreational programs, and other means of bolstering employee morale. Visiting nursing services are important wherever practicable.
15. Health and safety *educational* programs are of great importance to keep the workers physically fit. These should include teaching employees the principles of proper posture, nutrition, personal hygiene, prevention of disease, sanitation, and proper recreation. Executives must not be overlooked in this connection.

Off the Job

1. Plant management and community officials should exert every effort to prevent delays in the *transportation* of employees to and from work.
2. Every effort should be made to provide adequate and sanitary *housing* facilities for employees and their families.
3. All agencies should coordinate their efforts to secure adequate *medical, dental, and nursing* care in defense communities, and to provide adequate *hospital* facilities. In some isolated communities the large plants may be required to extend the scope of their medical care to all illnesses and injuries suffered by the worker and his family, in view of the increasing shortage of physicians and nurses.
4. Official and volunteer agencies should teach homemakers the value and the principles of proper *selection and preparation of foods* for both the worker's table and his lunch box. Mealtimes for the night worker should be

adjusted so as to bear about the same relation to his work as do those on the day shift.

5. Each worker should attempt frequently to enjoy some form of suitable *recreation*, such as baseball, bowling, dancing, or similar activities. Motion picture and radio schedules should be arranged for the benefit of night workers.
6. Every employee should obtain adequate *sleep*. Most workers require 8 hours and none less than six. A heavy meal or intoxicating liquor just before going to bed may nullify the beneficial effects of sleep. Night shift workers should attempt to adjust their time of sleeping to the job so as to correspond to the day work schedule.
7. Excessive use of alcoholic beverages must be avoided if the worker is to keep fit and efficient.
8. Emotional conflicts in the home should be kept at a minimum. The family physician particularly is in a position to be helpful in advising his patients on domestic difficulties so as to minimize emotional disturbances.

In the final analysis, the ultimate responsibility for keeping fit depends on the employee himself. It is up to him to do his part by taking full advantage of the opportunities offered for health and safety in the plant, and see that his life outside the plant is conducted in a similar manner, so far as within his control.

Role of Industrial and Family Physicians

The medical profession plays a most important role in increasing war production by maintaining and improving the workers' health. The *industrial physician* through his daily contacts with workers, his frequent inspections of the plant and observation of workers at their job, his study and analysis of sickness and accident data, and his general knowledge of the workers' problems is in a strategic position to detect and help control unfavorable conditions in the plant that are causing undue fatigue, as well as other detrimental factors in the working environment. In his capacity as the plant's health officer he is able to help coordinate the activities of the medical department, the safety department, the welfare division, plant officials, private physicians, and local health departments in bettering the health and efficiency of the workers. He should supervise and educate the workers on nutritional problems. As inadequate food intake is an important cause of fatigue and illness, especial care must be taken to insure an adequate supply of food to these workers.

It is vital for men at heavy manual labor to receive an adequate supply of carbohydrates and fats, even if it becomes necessary to place restrictions on the general population.

Family physicians caring for industrial workers should be increasingly alert to detect illness or other harmful effects of the patient's occupation on his health, and consult with the plant physician or officials regarding the prevention of such illness. They can accomplish a great deal by advising their patients on hygiene and on health maintenance, as well as to minimize the serious effects of ordinary illnesses. They can work hand in hand with the plant and community officials in promoting a health and sanitation program throughout the community, and help to bring all the benefits of preventive medicine to the workers and their families. In addition, most of the highly industrialized States now have official industrial hygiene units to give technical and advisory services on industrial health problems.

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CHAPTER 17

NUTRITION IN INDUSTRY

R. F. Sievers, M.D., Ph.D.

NUTRITION is one of the most important factors in the health and morale of industrial workers. This factor has gained increasing importance due to a growing appreciation of the existence of what some nutritionists have called a *subnutritive* state or *hidden hunger*, by which is meant a moderate degree of dietary deficiency of some kind. Wilder¹⁰ has pertinently remarked:

Nutritional deficiency saps vitality in so insidious a way that the victim may be unaware that enough is wrong to call a doctor. . . . The milder degrees of nutritional deficiency, although they are neither fatal nor completely incapacitating, constitute the nub of the problem of malnutrition. . . . They undermine the will to do. . . . They seriously depress resistance to other diseases, and in women contribute to the occurrence of complications during pregnancy. . . . The undernourished are unable to hold jobs if they find them; they become unemployable.

There is evidence that American workers' families, in a large percentage of cases, have been existing on diets considerably below the level considered adequate by leading nutritional authorities. It appears obvious that there is a need for improved diet among many industrial workers to promote optimum efficiency and prolonged physiologic well-being which will result in greater work capacity, fewer absences from work, and a decrease in the number of accidents.

For good nutrition, it is essential to have a proper balance of energy requirements, protein requirements, inorganic elements, and vitamins.

Energy Requirements

The Food and Nutrition Board of the National Research Council, in its Recommended Daily Allowances for Specific Nutrients, gives the standards, on page 326, for energy requirements.

To estimate properly the energy requirements of a worker, it is necessary to allow for the extra calories consumed beyond

the fixed working hours for some of the ordinary pursuits of pleasure and relaxation, such as carpentry, painting, gardening, running, and swimming.

Type of Activity	Calories per Day	
	Man, 154 lbs.	Woman, 123 lbs.
Light (sedentary).....	2,500	2,100
Moderately active.....	3,000	2,500
Very active.....	4,500	3,000

Recent investigations¹ indicate that *frequency of meals* bears an important relationship to fatigue. It is well known that hunger is associated with weakness, irritability, diminished ability to concentrate, and disinclination to work. A distinct rise in muscular efficiency after meals has been reported. In controlled studies the productivity of workers accustomed to three meals a day improved significantly when the workers were given additional light lunches, such as bananas, milk and bananas, or Oslo meal at mid-morning and mid-afternoon rest periods. There is no violation of the principles of good nutrition in the use of more frequent meals, provided the total daily food intake is thereby not made excessive, and provided the requirements of a well-balanced diet are met.

The foods served between meals should meet other qualifications which are important in dispensing supplementary feedings to workers throughout the plant. The food should require but little preparation, should be easily and quickly consumed, and easily preserved with little or no danger of contamination. It should not come in contact with the worker's hands, and must not leave an organic residue to litter the manufacturing areas. These feedings must appeal to a wide range of tastes even with repeated use, be readily digestible, and rarely cause gastric disturbances.

Protein Requirements

Of the 22 or more known amino acids, 9 or 10 are considered indispensable. These 9 or 10 indispensable amino acids have to be supplied by the proteins in the diet since they cannot be synthesized by the body at all, or at rates sufficient to supply the body's needs for them. As yet no specific syndrome is attached

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to a deficiency of an indispensable amino acid in the human being. The best sources of essential amino acids are of animal protein rather than cereal or vegetable origin, and for that reason the former is considered of higher nutritive value. For the average adult, it is estimated that the source of protein should be equally divided between animal and vegetable protein.²

Some authorities recommend a high daily protein requirement, others a low. A conservative estimate of the protein requirement is set forth by the Food and Nutrition Board. They recommend 70 grams per day for a man and 60 grams per day for a woman, assuming a diet meets the caloric requirements. A serving of meat, fish, or chicken ($\frac{1}{4}$ pound), one egg, 2 glasses of milk, and 6 slices of bread would supply the man's daily requirement.

Inorganic Requirements

Some of the inorganic elements are present in and required by the body in rather substantial amounts, notably calcium, iron, magnesium, phosphorus, sodium, chlorine, potassium, magnesium, iodine, and sulfur. Some very small quantities of other elements are essential to life, many of which, however, have not yet been subjected to a test adequate to determine whether or not they should be added to the list of indispensable food elements. Special attention must be paid to certain of the essential inorganic elements, namely, calcium, phosphorus, iron, and iodine, because optimal amounts of these are least likely to be provided by the hit-and-miss methods of food selection.

Calcium and phosphorus are the minerals most likely to be low in the average American diet. An inadequate calcium intake produces a gradual decalcification of the bones. Fractures occur as a result of insignificant little jolts and tumbles, particularly among adults of middle age, and beyond. A weak skeleton is a hazard in the ordinary pursuits of life, as well as in the industrial occupation. For the prevention of this condition, the best advice that can be given is to supply the body with liberal amounts of calcium and phosphorus, as the bone develops new structure in which these elements can be deposited, and to continue supplying about 0.8 gm. of calcium and about 1.3 gm. of phosphorus daily thereafter. Of the ordinary foods, not one is superior to milk as a source of calcium and phosphorus; *a pint of milk per day for every adult would be most helpful in fulfilling these requirements.*

The principal sources of *iron* are eggs, lean meats, leafy green

vegetables, mature peas and beans, whole grain cereals, and enriched breads. The usual guide for planning an adequate diet includes an iron intake of 10 to 15 mg. a day. The only iron absorbed is the available iron and the above allowance, on the basis of recent studies, appears to be ample.

As is now generally known, *iodine* deficiency is common in certain areas of this country. The deficiency can be avoided in these regions by the use of iodized salt. The inclusion of generous amounts of sea food in the diet also provides an ample supply of iodine. The daily iodine requirement for an adult is approximately 0.045 mg. The thyroid is capable of storing excess iodine and for that reason iodine need not be present in the diet daily.

For certain groups of industrial workers, one of the inorganic substances of specific concern is *sodium chloride*. The ordinary daily consumption of sodium chloride varies from 10 to 20 grams and most of it is obtained as seasoning for foods. Occupations resulting in profuse sweating may readily lead to heat cramps or exhaustion which is associated with serious salt depletion. The loss of salt is greatest during the initial period of exposure to heat. As much as 30 grams of salt may be lost in the perspiration during the first few days, followed by a noticeable decrease in salt loss after physiologic adjustment to excessive heat is completed. Therefore, new men in particular should be given extra salt when starting to work in a hot environment.

Sodium chloride may be administered in solution or tablet form. Steel companies have found that a 0.1 per cent solution of salt in water cooled to 46° F. is agreeable to their workers.³ When taken in tablet form, the salt should be followed by a copious amount of water to avoid the nausea frequently caused by a concentrated salt solution in the stomach. The amount of salt to be given may vary from several grams to 15 grams a day, in addition to that contained in the diet, depending entirely upon the type of work and environment. Although additional salt is essential to the health of those doing heavy manual labor in high temperatures and low humidities, it is doubtful whether sedentary workers need to be provided with salt tablets. The prevention of heat exhaustion consists merely in the ingestion of sufficient salt, though the mistaken idea persists that glucose is also protective.

Vitamin Requirements

Much emphasis is being placed on vitamin deficiency as a form of malnutrition. The importance of a sufficient supply of

vitamins is receiving increased attention and recognition. Doctors long have recognized severe deficiency diseases such as pellagra, beri-beri, scurvy, and rickets. The attention now is being turned to the recognition of the more subtle forms of malnutrition and their relationship to the vitamin intake. Evidence slowly being accumulated indicates that inadequate diets may be responsible for such vague symptoms as easy fatigue, indigestion, loss

TABLE 1.—CHART OF RECOMMENDED DAILY ALLOWANCES FOR SPECIFIC NUTRIENTS.¹ (Committee on Foods and Nutrition, National Research Council.)

Age and Sex	Calories	Protein (Gm.)	Calcium (Gm.)	Iron (Mg.)	A ² (I.U.)	Thiamin (B ₁) ² (Mg.)	Ascorbic Acid (C) ² (Mg.)	Riboflavin (Mg.)	Nicotinic Acid (Mg.)	D (I.U.)
Man (70 kg.):										
Moderately active...	3,000	70	0.8	12	5,000	1.8	75	2.7	18	....
Very active.....	4,500	....	....	....	....	2.3	....	3.3	23	(*)
Sedentary.....	2,500	....	....	....	....	1.5	....	2.2	15	....
Woman (56 kg.):										
Moderately active...	2,500	60	.8	12	5,000	1.5	70	2.2	15	....
Very active.....	3,000	....	....	....	....	1.8	....	2.7	18	(*)
Sedentary.....	2,100	....	....	....	....	1.2	....	1.8	12	....
Pregnancy (latter half).....	2,500	85	1.5	15	6,000	1.8	100	2.5	18	400-800
Lactation.....	3,000	100	2.0	...	5,000	2.3	150	3.0	23	400-800
Children up to 12 years:										
Under 1 year ⁴	100 per kg.	3-4 per kg.	1.0	6	1,500	0.4	30	0.6	4	400-800
1-3 years.....	1,200	40	1.0	7	2,000	0.6	35	0.9	6	....
4-6 years.....	1,600	50	1.0	8	2,500	0.8	50	1.2	8	....
7-9 years.....	2,000	60	1.0	10	3,500	1.0	60	1.5	10	(*)
10-12 years.....	2,600	70	1.2	12	4,500	1.2	75	1.8	12	....
Children over 12 years:										
Girls:										
13-15 years.....	2,800	80	1.3	15	5,000	1.4	80	2.0	14	....
16-20 years.....	2,400	75	1.0	15	5,000	1.2	80	1.8	12	(*)
Boys:										
13-15 years.....	3,200	85	1.4	15	5,000	1.6	90	2.4	16	....
16-20 years.....	3,800	100	1.4	15	6,000	2.0	100	3.0	20	(*)

¹ These are tentative allowances toward which to aim in planning practical diets. These allowances can be met by a good diet of natural foods; this will also provide other minerals and vitamins, the requirements for which are less well known.

² One mg. thiamin equals 333 International Units; 1 mg. ascorbic acid equals 20 International Units (1 International Unit equals 1 U.S.P. unit).

³ Requirements may be less than these amounts if provided as vitamin A, greater if chiefly as the provitamin carotene.

⁴ Needs of infants increase from month to month. The amounts given are for approximately 6-18 months. The amounts of protein and calcium needed are less if from breast milk.

⁵ Vitamin D is undoubtedly necessary for older children and adults. When not available from sunshine, it should be provided probably up to the minimal amounts recommended for infants.

⁶ Allowances are based on the middle age for each group (as 2, 5, 8, etc.), and for moderate activity.

of weight, depression, retarded learning, interference with vision, and lowered resistance to disease.⁴ Stomatitis, dental caries, cheilitis, glossitis, and bleeding gums are evidences of malnourishment seen daily by the dental profession. It is also known that with increased strain and activity the need for certain vitamins, such as thiamin, increases.⁵ Malnutrition of the types just described is believed to be widespread throughout the working population of this country.

There has been an unfortunate trend to promote the distribution of polyvitamin capsules to industrial workers in order to combat the deficiencies that may exist.⁶ For the *treatment* of vitamin deficiency diseases, the use of vitamin concentrate is amply justified. The practice of employers in their anxiety to obtain better nutrition among their workers by distributing synthetic vitamins in varying doses is not recommended by the National Research Council's Committee on Nutrition in Industry.

Physicians are, of course, aware that many factors in addition to vitamins are required to prevent undernourishment. The Food and Nutrition Board of the National Research Council states that "supplementing the diet with synthetic vitamins fails to make provision for deficiencies in protein, fats, carbohydrates, minerals, and the numerous accessory factors which have not been made available in crystalline form, but are nevertheless essential for the maintenance of health."⁷

According to this same Board, proper nutrition requires "the daily consumption of *at least* one pint of milk; two servings of potatoes; two servings of fruit, one of which should be a citrus variety or tomato; two vegetables, one of which should be leafy, green or yellow; one egg; one serving of meat, fish, or poultry; a cereal dish (whole grain); whole-grain or enriched white bread at every meal; and butter or fortified oleomargarine, the remaining calories to be supplied by a choice of vitamin-rich foods."

Table 1 gives the daily allowances for specific nutrients as recommended by the National Research Council.⁸

The Problem of Improving Nutrition in Industry

The majority of the workers in this country still carry their midshift meal in lunch boxes. Many reasons account for this practice. In many plants no provision is made for serving food. Some plants are so extensive that the single cafeteria is inaccessible to the major portion of the plant population, or the lunch period is too short. A number of the workers carry their lunches for economic reasons, while others find the cafeteria meals unsatisfactory either as to cost or quality, or both.

Recent surveys of plants with cafeterias indicate that a large per cent of the workers choose luncheon combinations that are poorly balanced even when a good combination is available. The sales of candies, soft drinks, and coffee are high, whereas the sales of milk and orange juice are distressingly low. This undesired ration is often stimulated by disparity in prices, milk and orange juice being several cents higher.

Another serious problem is the poverty of cooking and serving facilities in many of the rapidly expanding plants. The situation is further aggravated by the low-grade restaurants which spring up around the plants, over which the plant management has no control. The culinary facilities in the homes of these areas are often grossly inadequate. Workers often come to work without any breakfast, consuming doughnuts or sweet rolls, and coffee after their arrival at the plant.⁹

It has been authoritatively stated that one-half of our fuel is eaten in the form of sugar and bread. To this may be added the refined fats which make two-thirds of our energy intake in the form of *inert calories*, furnishing fuel only and nothing else. In many instances, a limited food budget is spent unwisely, while in other instances fixed or faulty food habits prevail.

These findings referring to the factory and home make clear that while nutrition is an individual and family problem, it is also an industrial problem. There are a number of ways in which industrial leaders can help to improve the nutritional status of all their workers. The three main lines of attack could be directed toward *education, provision, and economy.*

Education.—The following channels for the distribution of pertinent information are recommended by the National Research Council:⁷

1. A trained dietitian, employed in the medical department and under the direct supervision of the plant physician, can be made available to the employees and their families for advice on diet.
2. Information on nutrition . . . can be made a regular feature of the plant's or employees' publications.
3. Pay-envelope slips, listing items of food of good nutritional value which are in season or on the market at reasonable prices, may be used where this method meets with the favor of workers.
4. Posters or displays emphasizing the importance of good nutrition, or creating an interest in good food habits can be placed at strategic sites about the plant, especially where employees must pass or wait in line. Material which can be changed from time to time or which provokes a personal interest in the program should be especially effective.
5. Pamphlets on nutrition, provided by such agencies as the Bureau of Home Economics of the Department of Agriculture, can be distributed to the workers and their families.
6. Classes and demonstrations on nutrition can be conducted by the plant physician or dietitian, or by qualified representatives of local nutrition groups, for the wives and families of employees.
7. The maintenance of a cafeteria system where foods of high nutritional value are served in an attractive fashion so that the employees learn to appreciate their gustatory possibilities as well as their nutritional worth, is another avenue of approach.

8. When conditions permit the workers to have gardens, either at their homes or on company-owned property, their diet may be considerably improved by the use of garden produce. Efforts of the employes may be encouraged and aided by contests, classes in gardening, and collective purchase of tools and seeds. Advice and assistance for such a program may be obtained from the United States and State Departments of Agriculture, the State University, and the County Agricultural Agents.

Provision.—Industry should be interested in the foodstuffs served in the plants at the mid-day lunches and any supplementary feedings furnished between meals. A good meal must include a fish or meat dish, fruit or vegetable, and milk or a milk dish. The meal served in the plant should contribute at least one-third of the daily requirements of specific nutrients recommended by the Food and Nutrition Board of the National Research Council (see Table 1).

Proper preparation of the food is essential. Vegetables and salads especially should be prepared in an attractive manner, with minimum losses in their vitamin and mineral content. Because of economy, much of the white bread served in plant cafeterias is not enriched. The use of *enriched white bread or whole grain* products should be one of the important requirements. Milk and fruit and tomato juices are to be preferred as beverages. Many workers bring their own lunches and select only coffee, soft drinks, or candy as supplemental foods from lunch carts which invariably contain nonessential foods. The placement of a wide variety of the so-called protective foods on these traveling lunch wagons should be strongly encouraged.

A *minimum lunch period* of 30 minutes is recommended. Where distances from the workrooms to the cafeteria are too great, hot meals should be brought by preheated food conveyors and served to workers in areas set aside near their work centers. These food conveyors should run on a definite time schedule to permit the optimum usage of the lunch period at each station. In some areas of the country arrangements with the Red Cross volunteer canteen workers have been made to provide meals where cafeterias or the food conveyor service was impracticable.

A *nutritionist or dietitian* attached to the medical department can be of invaluable assistance by being placed in a supervisory capacity over the cafeteria systems, besides offering advice to malnourished workers.

Economy.—It is imperative that good meals be provided at reasonable prices for a successful nutritional program. The National Research Council believes:*

All cafeterias, kitchens, lunch stands, etc., should be under plant management and run on a nonprofit, nonloss basis. A cafeteria should not be a means of obtaining funds for employe functions or benefits, or any other extraneous purpose. . . . It was found that cafeterias, rolling kitchens, or lunch stands operated by concessionaires, whether the concessionaire were a private company or an employes' benefit association, were generally less satisfactory than management-owned cafeterias. Concessions are generally run on the "we give the men what they want" policy. Candy, pies, cakes, and soft drinks are apt to constitute too great a proportion of their stock.

A well-trained dietitian managing the cafeteria can keep down the costs by intelligent marketing. Having the knowledge of when and where to buy, as well as an understanding of the quality and nutritive value of foods, is a phase in a dietitian's professional training of particular value in low-cost feeding.

Recommendations

There is a need to inspire workers with the desire to be as healthy as possible, to give them the information to keep them healthy, and to help them apply this information. Industry, as one of its health measures, might well make use of a number of organizations for securing advice and assistance to improve the workers' nutrition. A number of these national and local agencies, both private and public, have joined together to conduct a nationwide program for the promotion of better nutrition. There are organizations representing various parts of the food industry, the National Dairy Council, for example, which have a valuable contribution to make through their posters and other material prepared for use in the broad educational field concerning nutrition. Material of this nature is also available from Federal agencies, such as the U. S. Department of Agriculture Bureau of Home Economics, Children's Bureau, National Institute of Health, National Red Cross, and numerous State agencies such as departments of home economics of State universities and State nutrition committees and their subsidiaries. Information about all the government agencies disseminating data relative to nutrition may be secured from the Nutrition Division of the Office of Defense Health and Welfare Services, Federal Security Agency, Washington, D. C.

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SECTION II

CHAPTER 18

COMMUNITY SANITATION

Richard T. Page, S.M.

ENVIRONMENTAL factors usually considered beyond the jurisdiction of the employer, may exert profound influences on the mental and physical health of workers. The problems effected by these factors can frequently be anticipated and their solution determined by proper consideration of community sanitation before constructing or enlarging war industries. Unfortunately, the pressing demands for materials of war in unpredictable quantities, and the necessity for utilizing and enlarging available plants, have created many problems which could have been avoided by proper planning.

Under ordinary peacetime conditions, the industrial worker spends less than one-third of his time at his place of employment, and even under the unusual stresses of war production we know that any appreciable increase in this ratio of working time to rest and recreation time will not increase and may decrease total production. (See chapter on *Industrial Fatigue*.) The home and community environments have an influence on the worker's health and also bear an important relationship to the so-called nonoccupational diseases, which are a major cause of time lost from work. For this reason, attention must be given to factors outside the workroom which have a bearing on a worker's health and efficiency. A worker's production may be reduced by mental agitation resulting from illness in his family caused by adverse environmental factors as well as by his own physical disability.

Community sanitation includes the provision of proper cleanliness in all of the community components, including industrial plants and private homes. Industrial sanitation has been fully discussed in preceding chapters and will be considered here only in its external effects upon the community. The sanitation of private homes is only slightly under the control of the public health

official, but it offers a fertile field for the public health educator. The present treatment of community sanitation will be primarily limited to those environmental factors detrimental to the health of the worker, which are subject to engineering control on a community basis but are ordinarily beyond the control powers of individual workers or employers.

Although community sanitation is usually the direct responsibility of the official sanitary engineering services, a governmental agency can only succeed with the wholehearted support of all components of the community. The sanitation problems have been intensified in communities containing plants engaged in war production, and in neighboring residential communities supplying labor to such plants. Consequently, it is the duty of employers, and the industrial physicians who are their representatives in health conservation, to support—and if necessary to initiate—sanitary control of health hazards in the communities in which their employees reside.

The community, individually or through State or Federal agencies, requests and, if necessary, demands that an industrial plant provide a sanitary and healthful working environment for its employees. Industry, as a vital part of community life, should expect the same high standards to be maintained outside the plants. The industrialist's active interest in community sanitation is always desirable; in war industries it is becoming imperative. The problem of providing sanitary facilities and enlarging inspection services in war production communities is as worthy of consideration as the problems of medical care, and industrial hygiene and sanitation.

General sanitation has little effect upon the contagious diseases, such as smallpox and measles, which are transmitted by direct contact between individuals, but many of the communicable diseases can be controlled by proper sanitation of water, milk, and food supplies, and the control or eradication of insect and animal carriers of disease. Vaccination is the only satisfactory control method for smallpox, but medical prophylaxis and environmental sanitation must both be used in preventing the spread of most communicable diseases. An epidemic of bubonic plague or Asiatic cholera would be a far more serious setback to our democratic aims than the loss of several major battles, and these diseases cannot be controlled by medical prophylaxis. Even the immunization of individuals against such diseases as typhoid fever, yellow fever, typhus fever, and Rocky Mountain spotted

fever can only be considered as emergency measures, necessary where engineering control measures are inadequate. Complete immunization of a civilian population is improbable except in time of epidemic, and is then only possible for a few diseases. Moreover, immunization is no justification for providing infected milk, contaminated drinking water or contaminated food.

Since there are available such excellent texts on community sanitation as those prepared by Boyd,¹ Rosenau,² Dunham,³ and Steel and White,⁴ only the major problems will be presented illustrative of the importance of the subject.

COMMUNITY SANITATION'S EFFECT ON INDUSTRY

Before considering the broader aspects of community sanitation we should realize that the community environment directly affects the industrial environment. The effects are manifested in many ways, but most obviously through the mediums of air, food, and water.

In most instances, the major problems in atmospheric contamination are of industrial origin, but smoke pollution from domestic sources may also be a serious factor. While the direct effects of smoke upon health are obscure, the esthetic and economic aspects are well recognized. The outstanding example given by the City of St. Louis, Missouri, of how successfully a community can control a smoke pollution problem shows that no community must be burdened with this nuisance.

The control of milk and other foods in the community, as well as the supervision of food handlers, is directly reflected in industry. The quality of food and the health of food handlers may be the direct responsibility of industry only in those instances where cafeterias or lunch services are provided. Nevertheless, industrial management has a moral obligation not only to comply with local milk and food ordinances, but also to make sure that these ordinances are comprehensive in scope and adequately enforced. The requital of this obligation should pay dividends in increased production.

Most industries are completely dependent upon community facilities for provision of their drinking water supply. The responsibility for the dispersion and dispensation of pure water inside the plant has been mentioned previously, but it is obvious that both employer and employee have a paramount interest in assuring that the water delivered to the plant is safe and palatable. Cooperation with the community and State agencies to

insure that drinking water supplies comply with recognized standards of purity will achieve this result.

INDUSTRY'S EFFECT ON COMMUNITY SANITATION

From the viewpoint of the public health engineer, industrial establishments contribute many problems to community sanitation. The most severe problems are atmospheric pollution and stream pollution.

Atmospheric Pollution

Atmospheric pollution is a much discussed and well documented subject which will be considered very briefly. Obviously every industrial plant should be so designed and operated that toxic quantities of noxious gases, fumes, and dusts will not be dispersed into the atmosphere. The control of these waste products at their source is essential since practicable means are not available for protecting people outside industrial plants against the cumulative effects of breathing toxic dusts and gases. While the number of uncontestable cases of chronic poisoning from this source is limited, the war industries are dealing with many new compounds of undetermined toxicity, and are making new^o uses of compounds of known toxicity. *Any atmospheric contaminant should be viewed with suspicion until irrefutably proved harmless.*

Water Pollution

The sanitation problems resulting from stream pollution by industrial wastes have been greatly increased by the war production program. Industry should and does expect the community to provide a pure water supply. The *dumping of industrial wastes* into our rivers and streams is an unjustifiable although time-honored practice which should be discontinued. But, we must face the fact that the practice will not and probably cannot be eliminated at this time. Nevertheless, while the dumping of obnoxious but nontoxic wastes may have to be condoned, the dumping of highly toxic materials may produce fatal consequences. Fairhall⁵ has shown the necessity for removing such contaminants as arsenic, boron, chromates, fluorides, lead, manganese, and selenium. Other contaminants such as titanium, picric acid, explosives and by-products of explosive manufacturing are potential hazards about which we need more information.

The burden on water treatment plants, however, can be greatly reduced if industry will cooperate with local and State sanitary engineers by informing them as to the quantity and composition of the wastes they are dumping or expect to dump. With this information, the sanitary engineer will be in a position to recommend primary treatment methods at the industrial establishment or be able to institute water purification methods which will remove the pollutants from public water supplies.

Industry should also cooperate with the sanitary engineer in preventing the installation, or the creation of unintended *cross-connections* between impure industrial water supplies and the drinking water supply. Direct connections between different water supplies are sometimes considered necessary for fire protection but are seldom justified. Such connections should be properly guarded and should have the approval of the health department. Unintended cross-connections between pure water lines and impure supplies or sewers should be eliminated. Such cross-connections can best be located by a survey of the type described by Cronkright and Miller.⁶

ELEMENTS OF A COMMUNITY SANITATION PROGRAM

Before considering the elements of a community sanitation program which are essential to the health of the worker and his family, attention should be recalled to one of the many environmental problems which is outside the jurisdiction of the sanitary engineer, but of vital importance in his work. This problem has to do with transportation.

The fatigue resulting from traveling long distances between residence and factory has been discussed in the chapter on *Industrial Fatigue*. This travel is occasionally the result of the temporary nature of the employment, but is more often due to the lack of housing facilities in the vicinity of the industry. The provision of adequate housing facilities is not a function of the health department, but their absence increases public health problems in several ways. First, where industrial plants are built, or expanded in small communities which cannot provide adequate housing, provision must be made, not only for increasing housing facilities but also for expanding the community sanitation program to care for the increased population. Second, until provisions for adequate housing and sanitation are provided, emergency measures must be taken to care for the situation. To date,

it appears that our most serious problems have resulted from the sudden overloading of housing and sanitation facilities in areas near construction projects for Army camps and war production industries.

The authorities responsible for the construction as well as those responsible for the operation of plants should cooperate with health authorities in making a careful survey of the community sanitation facilities to determine necessary improvements. When circumstances require the construction of establishments at appreciable distances from available sources of labor, a planned program of this type will eliminate severe hardships on workers. If such a survey was not made prior to starting production, immediate appraisal of the situation is recommended.

The following major elements of a community sanitation program should be considered in this type of survey: (1) housing, (2) water supply, (3) milk control, (4) food sanitation, (5) sewage disposal, (6) garbage and refuse disposal, and (7) control of insects and rodents.

Housing

A survey of sanitary facilities in a community should begin with an appraisal of the number and type of housing facilities, including single and multiple dwellings, apartment houses, and lodging houses. Zoning laws or regulations should be investigated. The number of available vacancies should be estimated to determine the number of additional housing units that must be provided. Provision should be made for emergency housing units—possibly in dormitories or trailer camps—if sudden large increases in population are anticipated during construction or before permanent housing facilities can be provided.

Surveys of housing facilities should also determine whether the workers' homes are (1) overcrowded, (2) unscreened—especially in malaria districts, and (3) insanitary. Community ordinances controlling sanitary provisions in public lodging houses should be established, or, if already in existence, should be enforced.

Water Supply

The provision of enough safe water for every worker's family should be insured. Sources of water supply, and the type and capacity of treatment and distribution systems should be investi-

gated. If water supply systems are not adequate for expected increases in population, immediate steps should be taken to have the municipal supply supplemented. The availability of emergency water supplies, and protective equipment such as emergency chlorinators, is desirable since such supplies may have to be utilized in case of destruction of supply mains or treatment plants by bombing or sabotage. It is also important that auxiliary sources of drinking water in common use such as springs, wells, and cisterns be inspected to insure the quality of the water.

Milk Control

Milk is one of the most universally used foods but it can also serve as a means of transmitting disease if its quality is not strictly controlled. It is an excellent bacterial culture medium and its organic composition prevents chemical sterilization. The problem is further complicated by the large number of producers and distributors usually encountered, as well as by the fact that milk is subject to contamination in the cow, during milking, and at every transfer and treatment point on the way to the consumer. The hazards from milk-borne tuberculosis, undulant fever, typhoid fever, septic sore throat, and other diseases can be minimized by constant application of the principles of sanitation to every step of the process. The following precautions are essential: (1) milk should be secured only from healthy cows shown by test to be free of tuberculosis and Bang's disease; (2) dairy barns and milk houses should be kept in a sanitary condition and operated in accordance with strict regulations; and (3) dairies, creameries, pasteurization plants, and distribution systems should maintain high sanitary standards. These ends can only be achieved if the health department inspection service is thorough, strict, and impartial.

Pasteurization of milk is always advisable as an extra precaution to insure safety, but it must be remembered that a high-grade pasteurized milk can only be secured by treatment of a high-grade raw milk. To secure this added protection, those who are dependent on raw milk can pasteurize it at home in the following manner: Heat the milk over a hot flame to 165° F., stirring constantly; then immediately place the vessel in cold water and continue stirring until cool.

The quality of a community milk supply is usually well reflected by the percentage of milk that is pasteurized. One method of improving a community milk supply is by adopting and en-

forcing the Standard Milk Ordinance of the U. S. Public Health Service.⁷

Food Sanitation

The control of other foods besides milk is frequently lax or non-existent in industrial communities. The provisions for food sanitation should be investigated. Provisions should cover the sanitation of slaughter houses, fish packing and shellfish industries, stores, bakeries, and other food industries as well as eating and drinking establishments.

The ordinance and code regulating eating and drinking establishments⁸ which is recommended by the U. S. Public Health Service embodies the latest information at present available on legislation relating to the public health supervision of such establishments. Its adoption by States, municipalities, and health districts is urged in order to encourage a greater uniformity and a higher level of excellence in the sanitary control of eating and drinking establishments.

Sewage Disposal

The sanitary disposal of sewage is essential from the public health viewpoint. It should be determined if the central system of the community is adequate to care for all workers' homes. If privies, outdoor toilets, or trailer toilets are used in the community they should be so constructed and maintained as to be fly-proof and to prevent pollution of the water supply. Epidemics resulting from such contamination are unnecessary and unjustifiable since they can be prevented by properly planned methods of sewage collection and treatment.

Garbage and Refuse Disposal

The collection of garbage and refuse is usually considered from the esthetic and economic point of view, but it has public health significance. Materials should be so stored, collected and disposed of that they will not tend to foster the breeding of flies and rats, or to create odor nuisances. To prevent the spread of trichinosis many communities have passed local ordinances which forbid the feeding of raw garbage to swine, although the use of cooked garbage for this purpose is permitted. Proper incineration of garbage and refuse is the best disposal method if salvage processes are not available or economically feasible.

Control of Insects and Rodents

A detailed discussion of insect-borne diseases or those transmitted by rodents is not pertinent at this time, but it should be remembered that flies, mosquitoes, ticks, fleas, and lice are representative of the insects transmitting such diseases as typhoid, malaria, spotted fever, plague, and typhus. The rat or other rodents serve as reservoirs for the last two diseases which might become mass killers if they reached epidemic proportions. They can be kept in check in this country by cooperative application of pest control measures.

It is reasonable to assume that the mass migrations of workers to war industry areas, as well as troop movements from one part of the country to another, must have resulted in the transfer of chronic, but active cases of malaria into areas which have been free of this disease. The *Anopheles* mosquito, which is the insect vector of this disease, is an habitant of many of these areas. When these mosquitoes become infectious by biting active cases of malaria, the malaria control program will have to be extended. Past experience has shown that malaria can become a serious problem even in northern States. Consequently, sanitary surveys should show not only the incidence of malaria, but also the presence or absence of mosquitoes which are potential vectors of the disease.

CONCLUSION

The knowledge that nine-tenths of the time lost from work on account of disability is due to non-industrial causes, and the nation-wide desire to keep war production at peak levels call for the cooperation of employers and employees with governmental health agencies to insure the maintenance of community sanitation programs. This can be done by insisting that the principles of sanitation, mentioned briefly here and discussed in detail in the following references, must be applied.

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CHAPTER 19

PLANT SANITATION*

Allen D. Brandt, D.Sc.

THE eleventh chapter was devoted to atmospheric sanitation, that is, maintaining the air breathed by the workers free from harmful concentrations of dusts, fumes, mists, gases, and vapors. This chapter pertains to the other phases of sanitation such as safe drinking water, sanitary disposal of wastes, and personal cleanliness. These two broad phases of sanitation, atmospheric and plant, are not unrelated. Good plant sanitation is essential to good atmospheric sanitation and vice versa. Whereas atmospheric sanitation pertains mostly to occupational disease prevention, plant sanitation pertains largely to the prevention of communicable diseases. The objective in both cases is the same, namely, to reduce illness and thereby to reduce lost time.

As in atmospheric sanitation there are three important steps for obtaining satisfactory plant sanitation: (1) provide good facilities and equipment, (2) maintain these facilities in clean and good working condition, and (3) educate the workers in the proper use of the facilities and in the need for good personal cleanliness. As a rule, it is better to use education than compulsion. Sometimes education and strict supervision are necessary to accomplish satisfactory results but compulsion alone seldom produces the desired results.

Plant sanitation has to do essentially with (1) water supply, (2) waste disposal, (3) washing facilities, (4) toilet facilities, (5) personal services, and (6) housekeeping. The minimum essential requirements for each of these six items to obtain satisfactory plant sanitation are summarized briefly in the following sections.

Water Supply

1. There should be provided in all places of employment a supply of clean, cool, wholesome, and safe drinking

* Based on an unpublished bulletin, "Basic Principles of Industrial Hygiene and Sanitation," by R. R. Sayers, J. M. DallaValle, and R. R. Jones, National Institute of Health, U. S. Public Health Service.

water approved by the local authorities having jurisdiction.¹ When safe water is not available, the State authorities should furnish directions for rendering it safe for human consumption.

2. The temperature of the water supplied for drinking purposes should not be lower than 40° F., nor higher than 80° F. (preferably between 45° and 50° F.), and if cooled by ice, the ice should not come in direct contact with the water.
3. Where sanitary drinking fountains are provided, they should be of an approved type and construction.² At least one drinking fountain should be provided for each 50 employees.
4. The common drinking cup should be prohibited. When individual drinking cups (to be used only once) are supplied, a suitable container should be provided for the unused cups and a receptacle for the disposal of the used cups.
5. Open containers for drinking water from which the water must be dipped or poured should not be allowed, even if fitted with covers.
6. Where water from an unapproved source is used for industrial processes or fire protection, notices should be posted stating clearly that such water is unsafe for drinking, and every reasonable effort should be made to prevent its being so used.

Waste Disposal

1. Waste receptacles of a type which can be kept clean and sanitary should be provided in all places of employment. These receptacles should be located convenient to the majority of workers.
2. An adequate number of waste receptacles of a type suitable for the purpose should be provided in and near all eating places, including lunchrooms and canteens.
3. Waste receptacles should be covered unless they contain nothing which will attract flies.
4. All waste receptacles should be emptied and cleaned as often as is necessary to maintain them in a sanitary condition.
5. All waste should be collected routinely and disposed of in a manner approved by the State health department.

6. Sewage likewise should be disposed of in a manner approved by the State health department.

Washing Facilities

1. Adequate facilities for maintaining personal cleanliness should be provided in every place of employment and should be maintained in a sanitary condition throughout. Separate washrooms should be provided for each sex.
2. At least 1 lavatory (wash basin) with adequate water supply should be provided for every 10 employees or portion thereof up to 100 persons, and 1 lavatory for each additional 15 employees or portion thereof. Twenty-four inches of sink with individual faucet may be considered equal to 1 basin. At least 1 wash basin should be provided in each toilet room or room adjacent thereto unless general washing facilities are on the same floor and near to the toilet room.
3. Every new wash basin installed should be made of vitreous, glazed, or enameled ware or similar material. Galvanized cast iron may be permitted for sinks.
4. One wash basin with hot and cold water from 1 faucet should be provided for every 5 employees and 1 shower with hot and cold water from 1 fixture for every 15 employees exposed to skin contamination with poisonous, infectious, or irritating material. For materials difficult to remove from the skin such as tetryl and TNT, the number of showers should be doubled.
5. The common towel is prohibited. Individual towels of cloth or paper and proper receptacles for disposing of used towels should be provided.
6. Soap in a suitable dispenser should be provided at each wash place. No strong alkali or harsh soaps should be permitted.
7. Oils or solvents used for removing contaminants from skin should be used sparingly.
8. Water from any source not approved by the State or local authorities should not be used for washing.

Toilet Facilities

1. Every place of employment should be provided with adequate water closets, chemical closets, or privies sep-

arate for each sex, in accordance with the following table in which the number of persons is the maximum number of each sex employed at any time on the premises for which facilities are furnished:

TOILET FACILITIES RECOMMENDED

<i>Number of Persons Employed</i>	<i>Minimum Number of Toilet Facilities</i>
1 to 9.....	1
10 to 24.....	2
25 to 49.....	3
50 to 100.....	5
Over 100.....	1 for each additional 30 persons

2. Chemical closets and privies should not be permitted except where no sewer is accessible and only when they can be kept under careful supervision.
3. All chemical closets should be of a type approved by the health authorities having jurisdiction and should be maintained in a sanitary condition. The containers should not be allowed to become more than two-thirds full, and contents should be disposed of in an approved manner.
4. Privies should not be permitted in establishments employing more than 25 persons. All privies should be constructed and maintained as given in the material cited.³ No privy should be permitted within 100 feet of any room where foodstuffs are stored or handled nor at any place where it cannot be constructed and maintained without danger of contaminating any source of drinking water.
5. Covered receptacles should be kept in all toilet rooms used by females.
6. An adequate supply of toilet paper, in proper holders, should be provided in each toilet room.
7. Adequate washing facilities should be provided in every toilet room or any room adjacent thereto unless the general washing facilities are on the same floor and in close proximity to the toilet rooms.
8. Toilet rooms should be not more than one floor above or below the regular place of work of the persons using them unless passenger elevators are available for the employees' use in going to and from toilet rooms.
9. Whenever urinals are provided, one closet less than the number specified in the above table may be provided

for males for each urinal, except that the number of closets in such cases may not be reduced to less than two-thirds the number specified in the table. Urinals should be made of materials impervious and resistant to moisture. The floor to a distance of not less than 24 inches in front of all urinals should be constructed of waterproof materials and should slope toward the urinal trough for all "floor-level" urinals. Every urinal should have an individual flush system using not less than one gallon of water per discharge. Water may be allowed to run continuously over slab urinals in place of a flush system.

10. The walls of compartments or partitions between fixtures may be less than the height of room walls but the top should be not less than 5 feet from the floor and the bottom not more than 1 foot from the floor. Compartment doors should be supplied with latches.
11. Toilet rooms should be fitted with self-closing doors which should be screened from workrooms. Toilet-room floors and walls to a height of 6 inches should be constructed of material impervious and resistant to moisture. Floors, walls, and ceilings should be of material easy to clean. All toilet rooms having windows should be equipped with screens. The windows should be translucent but not transparent.
12. In new installations the minimum floor space allotted for toilet facilities (closets), lavatories (wash basins), and urinals should be as follows:

SPACE ALLOTMENT FOR TOILET FACILITIES

Installation	Minimum Width (Inches)	Minimum Depth (Feet)	Minimum Floor Space (Square Feet)
Closets.....	32	3.6	16
Lavatories.....	24	3.6	12
Urinals.....	24	3.6	12

13. The construction and maintenance of toilet fixtures should comply with the State or local building and plumbing codes, where such codes exist. In other cases it is recommended that the instructions cited⁴ be followed. The

water-closet bowl should be set free and open from all enclosing walls so that space around fixture may be cleaned easily. If the water-closet seat is of absorbent material, it should be finished with light-colored varnish or other substance impervious to moisture.

Personal Services

1. In all places of employment where it is necessary for male employees to change clothes or where females are employed, separate dressing rooms with lockers should be provided and maintained in sanitary condition.
2. Dressing rooms should be provided for men whenever the type of work performed involves exposure to excessive dust, dirt, heat, fumes, vapor, or moisture of such degree as is declared by the enforcing authority to require the same. Two-compartment lockers, or preferably two individual lockers, should be provided in dressing rooms for employees whose clothes are exposed to contamination with poisonous, infectious, or irritating material. Workers exposed to toxic substances, such as TNT and tetryl, should be required to change clothes completely and to take a shower bath at the end of each shift. The work clothes should be provided and laundered by the employer.
3. A retiring room should be provided in all work places where 10 or more women are employed. Where less than 10 women are employed and a retiring room is not furnished, some equivalent space should be provided which can be screened properly and made suitable for use of women employees. The minimum space provided for a retiring room for 10 women should be 60 square feet. For each additional female employee there should be at least 2 square feet of floor space. At least one couch or bed should be provided in every place where more than 10 women are employed. The number of beds or couches required follows:

BEDS FOR FEMALE EMPLOYEES

<i>Number of Females Employed</i>	<i>Number of Beds</i>
10 to 100.....	1
100 to 250.....	2
Over 250.....	1 additional bed for each 250 additional women

4. In every establishment a separate lunchroom should be maintained unless it is convenient for the employees to eat lunch away from the premises. No employees should be permitted to eat lunch at their place of work or in the workroom. At least one-half hour should be allowed each employee for lunch. The following table gives the number of square feet which are required per person, based on the maximum number of persons using the room at one time:

LUNCHROOM AREAS RECOMMENDED		<i>Square Feet Per Person</i>
<i>Number of Persons</i>		
Less than 25.....		8
25 to 74.....		7
75 to 149.....		6
150 to 499.....		5
500 or more.....		4

Housekeeping

1. All places of employment, passageways, storerooms, and service rooms should be kept in a sanitary condition and the premises including the yards, courts, passages, areas, and alleys connected with the place of employment should be kept free from any accumulation of dirt, filth, rubbish, or garbage.
2. The floor of every workroom should be maintained in a clean, and, so far as possible, a dry condition. Where wet processes are used, reasonable drainage should be maintained and false floors, platforms, mats, or other dry standing places should be provided. The employer should, without expense to the employees, furnish proper boots or shoes for the use of the employees while at work in such places.
3. Floor and other walkway surfaces should be kept in good repair, and free from oil, water, protruding nails, splinters, holes, and loose boards.
4. So far as is practicable, sweeping and cleaning should be done outside of working hours and in such manner as to avoid the dissemination of dust. All sweepings, waste, refuse, and garbage should be removed as often as necessary to maintain the place of employment in a sanitary condition.
5. Expectoration upon the walls, floors, stairs, or equipment should be prohibited. Where cuspidors are needed, they

should be of the paper disposable type or should be cleaned daily.

6. Wherever mechanical or chemical equipment is used to maintain sanitation, periodic inspection is required to assure the efficiency of such equipment and a record should be kept of the results of each inspection.
7. Materials should be kept in shelves, bins, or lockers or should be piled neatly and safely in appropriate places.

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CHAPTER 20

ILLUMINATION, NOISE, AND RADIANT ENERGY

Allen D. Brandt, D.Sc., and Harry E. Seifert, C.E., M.S.P.H.

ILLUMINATION*

ON February 28, 1942, the Chairman of the War Production Board, announced that the President of the United States had officially launched a production drive with certain war production quotas which had to be met in that year. To meet the specified quotas each war production plant was asked to organize a Production Drive Committee to give close attention to such problems as: (1) taking care of tools, (2) preventing breakdowns, (3) cutting down accidents, (4) good lighting, (5) maintenance and repair, (6) adapting old machines to new uses, (7) cutting wastage, (8) breaking production bottlenecks, and (9) using every machine to the fullest extent.

From this list of nine items it will be recognized that the solution of the lighting problem will greatly contribute toward the solution of the others. In wartime good lighting might be classified as both an offensive and a defensive weapon. As an offensive weapon, it increases human efficiency and production by conserving priceless manhours. As a defensive weapon it minimizes eyestrain, reduces accidents and provides for human safety, and protects the manufactured products from the destructive effects of carelessness and sabotage.

BENEFICIAL EFFECTS OF GOOD ILLUMINATION

Illumination is a factor of primary importance which affects the environment in every industrial establishment. The beneficial effects of good illumination, both natural and artificial, have been established in extensive tests over many years. The advantages to industry are many: (1) greater accuracy of workmanship, resulting in an improved quality of product with less spoilage and rework, (2) increased production and decreased costs, (3) better utilization of floor space, (4) greater ease of seeing es-

* Based on information contained in material cited,¹⁸ with the permission of the Illuminating Engineering Society.

pecially among older employees, thus making them more efficient, (5) less eyestrain among employees, (6) improved morale among employees resulting in decreased labor turnover, (7) more easily maintained cleanliness and neatness in the plant, and (8) greater safety.

Greater Accuracy of Workmanship¹

Under good illumination it is possible to see an object of much smaller size than under poor illumination. Thus a closer check can be made throughout the manufacturing process which will result in earlier discovery of visible defects, permitting rejection prior to final inspection.

Increased Production

It takes time to see—the eye is somewhat like a camera in this respect. An increase in illumination from one footcandle to a moderate level of approximately 20 footcandles, a condition often occurring upon the installation of a modern lighting system, results in increasing the speed of seeing approximately three times.² This enormous improvement in perception and recognition of surroundings affects practically everything the worker does. It reduces the time required for seeing and some of this time, at least, becomes available for production. The experiences of many plants which have improved their lighting bear out this point.³

Better Utilization of Floor Space⁴

A uniform level of general lighting makes possible the most efficient arrangement of machinery and conveyors and better utilization of floor space. Manufacturers have discovered that more work can be achieved with less floor space when the work flows in straight lines through assembly or inspection sections. Good lighting facilitates such proper arrangement of the work and practically eliminates the likelihood for crowding.

Greater Ease of Seeing

Very frequently the older employee is well fitted physically and mentally for the responsible work for which his years of experience have prepared him. In many instances, however, failing vision will prevent such an employee from carrying on exacting work and thus he is relegated to simple routine tasks

in which his experience is of little value. It is desirable to preserve the experience of the older worker and receive the advantage of his long accumulated skill and knowledge.

It has long been known that as the eyes grow older there is a progressive loss in visual acuity and the prevalence of defective vision increases markedly. Much can be done to give assistance to eyes that are defective. Eyeglasses may correct refractive errors and permit the eyes to focus upon near and far objects. Higher illuminations are likewise an effective aid toward better seeing.

Many of these valuable, skilled, older workers can continue to perform efficiently if the simple expedient of assisting their eyes with good illumination is adopted.

Less Eyestrain

It should not be construed that good lighting is of assistance only to the older employees. Good lighting also aids all the visually handicapped to a greater extent than those with perfect vision, but even those in the latter group find, under good lighting, a noticeable improvement in eye comfort which results in reduced fatigue.

Improved Morale of the Employees

There is an important psychological effect connected with cheerful, pleasant, modern working surroundings as compared to the dim, gloomy interiors which were formerly so prevalent. In addition to the more cheerful appearance of a well-lighted interior, many minor frustrations due to poor lighting which continually harass the workers are eliminated; it is sufficient to refer to the difficulty in reading scales and micrometers, and to the finding of proper drills and other tools.

Plant Cleanliness

All industry has found that cleanliness invariably pays. Poor illumination makes it difficult to see into corners or under machinery and these dark areas inevitably collect dirt and waste which would otherwise be cleaned out. Where dirt can be seen it is more likely to be removed. In the well-lighted plant such dingy areas do not exist and sanitary conditions prevail.

In industrial plants that have their own engineering departments it is desirable that the combined efforts of the electrical engineering department, the operating department and the safety

department be enlisted to secure adequate maintenance of lighting equipment and to study lighting problems.

It is urged that those plants which do not have engineering departments consult a competent illuminating engineer.

Safety

Engineering for safe plant operation consists essentially of preparing a safe environment for the worker. The environment should be designed to match and to compensate for the limitations of human capability. On the other hand, the worker must understand his personal responsibilities regarding acts which might conceivably cause injury to himself or to others, and carefully follow plant safety regulations. The admirable activities of those organizations and individuals interested in the promotion of safety are successfully implanting this sense of responsibility in the individual worker.

However, as revealed by an analysis of accidents and their causes, this is but one phase of the safety problem. All personal injury accidents involve a combination of *personal* and *mechanical causes*. The chain of circumstances or series of causes which has brought a worker to the verge of an injury frequently can be broken only if the worker can see quickly and accurately the causes, and hence act to prevent the accident.

Any factor which aids seeing will increase the probability that the worker will detect the causes of an accident and act to avert it. It is realized that with rapidly-moving material, mechanical failures often result in accidents occurring too rapidly for any reaction on the part of the worker. However, mechanical failures of this nature are usually preceded by evidences of undue stresses or strains which may be detected if sufficient illumination is provided.

The close correlation between the personal injury rates and illumination is not generally understood. In most cases, where accidents are attributed to poor illumination, they occur because there is an improper quality of illumination or practically no illumination at all. Poor or indifferent lighting, even though it may provide measurable quantities of light, has been frequently overlooked as a contributing cause of accidents. Many factors associated with poor illumination, such as glare, light reflected from the work, and dark shadows, hamper seeing and cause after-images and excessive visual fatigue which are important contributing causes of industrial accidents. Many accidents are also

caused by delayed eye adaptation when coming from bright surroundings into dark interiors. Frequently accidents which are attributed to the worker's carelessness can actually be traced to difficulty of *seeing*.⁵

One important cause of industrial losses is the minor accident where the employee may or may not report for first aid but continues his work, with a decrease in the quantity and quality of his work.

The condition of the illumination at the point of accident and in the surrounding area should always be inspected and reported in accident investigations.

FACTORS OF GOOD ILLUMINATION

There are many factors involved in good illumination. Lighting installations, therefore, should be designed by a competent illuminating engineer. However, those who live with the lighting and those who must justify its cost should be acquainted with some of the factors to be considered. These can be summed up under the headings of *quality*, which includes, among other things, the color of light, its direction, diffusion, and absence of glare, and *quantity*, or the amount of illumination.

Quality of Lighting

The quality of the lighting⁶ whether natural or artificial is highly important in providing good seeing conditions. Glare, diffusion, direction, and distribution have significant effects on visibility and the ability to see easily, accurately and quickly.

Glare.—Glare may be defined as any brightness within the field of vision of such character as to cause discomfort, annoyance, interference with vision, or eye fatigue. It is one of the most common and serious faults of lighting installations.

Glare is objectionable because: (1) when continued it tends to injure the eye and disturb the nervous system; (2) it causes discomfort and fatigue and thus reduces the efficiency of the worker, and (3) it interferes with, and often prevents, clear vision and thus reduces efficiency, and in many instances increases the risk of accidents or injury to the workers. From both a humanitarian and a business viewpoint, the owner or operator of a factory should be interested in avoiding glare whether caused by daylight or by artificial light.

There are two common forms of glare, *direct* and *reflected*. *Direct glare* is caused by excessive brightness or brightness-con-

trast within the visual field, that is, unshielded lamps or high-brightness surfaces of fixtures.

To reduce direct glare from the artificial lighting, direct general-lighting luminaries should be mounted at a sufficient height to keep them well above the normal line of vision. They should be properly designed to limit both the brightness and the quantity of light emitted in directions directly below the horizontal since such light is well within the normal field of view and interferes with vision.

High brightness-contrasts should be avoided. For example, an unshielded lamp viewed against the low brightness of a dark ceiling may be very glaring, similarly, a bright window seen against darker surrounding walls.

Supplementary lighting sources should be carefully designed so that the light is confined to the immediate working area. Failure to observe this precaution may cause extreme annoyance not only to the worker using the source but to others in the vicinity. Care should also be exercised to prevent excessive brightness-contrasts between the work and the surroundings.

Reflected glare, as its name implies, is caused by high brightnesses, images or brightness-contrasts reflected from ceilings, walls, desk tops, or other surfaces within the visual field such as materials and machines. These brightnesses are accentuated when the surfaces are glossy or specular in character, such as highly-polished machine parts, smooth-finished surfaces, varnished table tops or other highly-reflective surfaces. Reflected glare is frequently more annoying than direct glare because it is so close to the line of vision that the eye cannot avoid it. The effect of reflected glare for a given image brightness is reduced with higher levels of general illumination due to the reduction in contrast.

*Diffusion and Distribution of Light.*⁶—Some directional and shadow effects are desirable in general illumination for accentuating the depth and form of solid objects, but harsh shadows should be avoided. Shadows are softer and less pronounced when diffusing units and units having a wide distribution of light are used, since then the object is illuminated from many sources. Alternate light and dark areas in strong contrast are undesirable because the eye has difficulty in adjusting itself to the two illuminations and seeing becomes tiring. For this reason, purely local lighting restricted to a small work area is unsatisfactory unless there is sufficient general illumination in the room.

Clearly defined shadows, without excessive contrast, are a distinct aid to sight in certain types of operations such as engraving on polished surfaces, scribed layout work, and textile inspection. When such shadow effect is indicated, it is best obtained by supplementary directional light combined with diffused illumination of ample intensity.

Much attention has been given to measurement of footcandles on the horizontal plane. Actually many of the seeing tasks in industry are on vertical or nearly vertical surfaces. Hence the amount and the distribution of light on vertical surfaces may be of great importance.

Color Quality of Light.—It appears that with equal footcandles of illumination, variations in color quality of light have little or no effect upon clearness and quickness of seeing.^{7, 8} A recent study has indicated that the same is true for fluorescent light.⁹ However, in certain industries color discrimination is highly important, and light sources which provide lighting that will enable the matching to be performed most accurately should be used. This again is a matter in which the illuminating engineer should be consulted.

Color of Surroundings.—Light-colored surfaces serve several purposes in the factory. They are of particular value in providing a high utilization of light because they reflect more light toward the working areas. Also, bright window areas and artificial light sources are less uncomfortable to the eye when viewed against light backgrounds.

Many progressive establishments are painting all of their machinery with light-tinted durable paints. This provides an increased amount of light which is reflected to the otherwise shadowed sections of the machine. Some manufacturers paint stationary and moving parts of machines different colors to aid seeing and thus prevent accidents.

Quantity of Light

The desirable quantity of light for any particular installation depends primarily upon the work which is being done. The degree of accuracy, the fineness of detail to be observed, the color and reflectivity of the work as well as of the immediate surroundings materially affect the distribution of brightness which will produce maximum seeing conditions. Investigations in the field and laboratory have proved that as the illumination on the task is increased, the ease, speed and accuracy with which the task can

be accomplished are increased. These tests have not yet established an upper limit but the harmful effects of low-foot-candle values are well known.²

It is possible to measure quantity of light quickly and with reasonable accuracy by the use of any of the various meters employing light-sensitive cells. These instruments are direct-reading and simple, but they should be calibrated at frequent intervals. It is highly important that the measurement be made at the point and in the plane in which the seeing task is performed, whether it be horizontal, vertical, or at some intermediate angle. If lighting is a combination of natural and artificial illumination, that part due to natural light should be measured separately from that due to the artificial light since in many instances at one hour of the day there is a great amount of natural light while at a different time it may fail entirely.

Brightness measurements hitherto difficult of accomplishment are now easily made with a Brightness Meter.

Recommended Minimum Standards of Illumination.—The majority of the recommended values of illumination in Table 1¹⁸ refers to the general lighting or lighting throughout the total area involved as measured on a horizontal plane 30 inches above the floor. In some instances where an illumination of more than 50 footcandles is necessary it may be obtained by a combination of general lighting plus supplementary lighting at the point of work. An asterisk after the footcandle figure denotes that the combination of general and supplementary illumination is desirable.

The Illuminating Engineering Society has been studying the illumination needs of specific industries in recent years. Wherever reports of these industries have been completed, the footcandles included in Table 1 are taken from the appropriate report. In other instances the values are based upon current good practice. These reports¹⁰⁻¹⁷ should be consulted for detailed lighting specifications for manufacturing processes.

Attention is called to the fact that the values given are minimum operating values; that is, they apply to measurements of the lighting system in use, not simply when the lamps and reflectors are new and clean—and in almost every instance higher values may be used with greater benefit.

To insure that a given illumination will be maintained even where conditions are favorable it is necessary to design the system to give initially at least 25 per cent more light than the re-

TABLE 1.—MINIMUM FOOTCANDLES IN SERVICE,¹⁵ RECOMMENDED MINIMUM STANDARDS OF ILLUMINATION FOR INDUSTRIAL INTERIORS. (These Foot-candle Values Represent Order of Magnitude Rather than Exact Levels of Illumination.)

	<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>		<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>
ASSEMBLY:		stationary and gravity	
Rough.....	10	crystallizers.....	5
Medium.....	20	Mechanical furnaces, gener-	
Fine.....	B*	ators and stills, mech-	
Extra fine.....	A*	anical driers, evapor-	
AUTOMOBILE MANUFACTUR-		ators, filtration, mech-	
ING:		anical crystallizers,	
Assembly line.....	B*	bleaching.....	10
Frame assembly.....	20	Tanks for cooking, extrac-	
Body manufacturing—		tors, percolators, nitra-	
Parts.....	20	tors, electrolytic cells..	15
Assembly.....	20	CLAY PRODUCTS AND CE-	
Finishing and inspect-		MENTS:	
ing.....	A*	Grinding, filter presses,	
BAKERIES.....	20	kiln rooms.....	5
BOOK BINDING:		Molding, pressing, clean-	
Folding, assembling, past-		ing and trimming....	10
ing, etc.....	10	Enameling.....	15
Cutting, punching and		Color and glazing.....	20
stitching.....	20	CLEANING AND PRESSING	
Embossing.....	20	INDUSTRY:	
BREWERIES:		Checking and sorting....	20
Brew house.....	5	Dry and wet cleaning and	
Boiling, keg washing and		steaming.....	10
filling.....	10	Inspection and spotting..	A*
Bottling.....	20	Pressing—	
CANDY MAKING:		Machine.....	20
Box department.....	20	Hand.....	50
Chocolate department—		Receiving and shipping..	10
Husking, winnowing,		Repair and alteration....	50
fat extraction, crush-		CLOTH PRODUCTS:	
ing and refining, feed-		Cutting, inspecting, sew-	
ing.....	10	ing—	
Bean cleaning and sort-		Light goods.....	20
ing, dipping, packing,		Dark goods.....	A*
wrapping.....	20	Pressing, cloth treating	
Milling.....	30	(oilcloth, etc.)—	
Cream making—		Light goods.....	10
Mixing, cooking and		Dark goods.....	20
molding.....	20	COAL TIPPLES AND CLEAN-	
Gum drops and jellied		ING PLANTS:	
forms.....	20	Breaking, screening and	
Hand decorating.....	50	cleaning.....	10
Hard candy—		Picking.....	A*
Mixing, cooking and		CONSTRUCTION—INDOOR:	
molding.....	20	General.....	10
Die cutting and sorting		ELEVATORS—FREIGHT AND	
Kiss making and wrap-		PASSENGER.....	10
ping.....	30	ENGRAVING.....	A*
CANNING AND PRESERVING.	20	FORGE SHOPS AND WELDING	10
CHEMICAL WORKS:		GARAGES—AUTOMOBILE:	
Hand furnaces, boiling		Storage—live.....	10
tanks, stationary driers,			

¹⁵ See reference footnote at end of table.

TABLE 1.—Continued

	<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>		<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>
GARAGES—AUTOMOBILE:—Cont'd.		LEATHER MANUFACTURING:	
Storage—dead.....	2	Vats.....	5
Repair department and washing.....	30	Cleaning, tanning and stretching.....	10
GLASS WORKS:		Cutting, fleshing and stuff- ing.....	20
Mix and furnace rooms, pressing and lehr, glass blowing machines.....	10	Finishing and scarfing....	30
Grinding, cutting glass to size, silvering.....	20	LEATHER WORKING:	
Fine grinding, polishing, beveling, etching and decorating.....	50	Pressing, winding and glazing—	
Inspection.....	B* C*	Light.....	10
GLOVE MANUFACTURING:		Dark.....	20
Pressing, knitting, sort- ing—		Grading, matching, cut- ting, scarfing, sew- ing—	
Light goods.....	10	Light.....	20
Dark goods.....	20	Dark.....	A*
Cutting, stitching, trim- ming, inspection—		LOCKER ROOMS.....	10
Light goods.....	20	MACHINE SHOPS:	
Dark goods.....	A*	Rough bench and ma- chine work.....	20
HANGARS—AIRPLANE:		Medium bench and ma- chine work, ordinary automatic machines, rough grinding, medi- um buffing and polish- ing.....	30
Storage—live.....	10	Fine bench and machine work, fine automatic machines, medium grinding, fine buffing and polishing.....	B*
Repair department.....	50	Extra fine bench and ma- chinework, grinding—	
HAT MANUFACTURING:		Fine work.....	A*
Dyeing, stiffening, braid- ing, cleaning and re- fining—		MEAT PACKING:	
Light.....	20	Slaughtering.....	10
Dark.....	30	Cleaning, cutting, cook- ing, grinding, canning, packing.....	20
Forming, sizing, pounc- ing, flanging, finish- ing and ironing—		MILLING—GRAIN FOODS:	
Light.....	20	Cleaning, grinding and rolling.....	10
Dark.....	30	Baking or roasting.....	20
Sewing—		Flour grading.....	30
Light.....	20	OFFICES:	
Dark.....	A*	Bookkeeping, typing and accounting.....	50
ICE MAKING—ENGINE AND COMPRESSOR ROOM.....	10	Business machines—pow- er driven (transcrib- ing and tabulating)—	
INSPECTION:		Calculators, key punch, bookkeeping.....	B*
Rough.....	20		
Medium.....	30		
Fine.....	B*		
Extra fine.....	A*		
IRON AND STEEL MANUFAC- TURING.†			
JEWELRY AND WATCH MAN- UFACTURING.....	A*		
LAUNDRIES.....	20		

* See reference footnote at end of table.

† Consideration is now being given to the proposition of issuing a report on recommended lighting practice for the entire iron and steel industry.

TABLE 1.—Continued

	<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>	<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>
Conference room—		
General meetings.....	25	
Office activities—See deskwork		
Corridors and stairways..	5	
Deskwork—		
Intermittent reading and writing.....	25	
Prolonged close work, computing, studying, designing etc.....	50	
Reading blueprints and plans.....	30	
Drafting—		
Prolonged close work, art drafting and de- signing in detail....	50	
Rough drawing and sketching.....	30	
Filing and index refer- ences.....	25	
Lobby.....	10	
Mail sorting.....	25	
Reception rooms.....	10	
Stenographic work.....	50	
Vault.....	10	
PACKING AND BOXING.....	10	
PAINT MIXING.....	10	
PAINT SHOPS:		
Dipping, simple spraying, firing.....	10	
Rubbing, ordinary hand painting and finishing art, stencil and special spraying.....	20	
Fine hand painting and finishing.....	B*	
Extra fine hand painting and finishing (automobile bodies, piano cases, etc.).....	A*	
PAPER BOX MANUFACTUR- ING:		
Light.....	10	
Dark.....	20	
Storage.....	5	
PAPER MANUFACTURING:		
Beaters, grinding, calen- dering.....	10	
Finishing, cutting, trim- ming, paper making machines.....	20	
PLATING.....	10	
POLISHING AND BURNISH- ING.....	20	
POWER PLANTS, ENGINE ROOM, BOILERS:		
Boilers, coal and ash handling, storage bat- tery rooms.....	5	
Auxiliary equipment, oil switches and transform- ers.....	10	
Engines, generators, blow- ers, compressors.....	20	
Switchboards.....	30	
PRINTING INDUSTRIES:		
Type foundries—		
Matrix making, dress- ing type.....	A*	
Font assembly—sort- ing.....	B*	
Hand casting.....	30	
Machine casting.....	20	
PRINTING PLANTS:		
Presses.....	30	
Imposing stones.....	A* C*	
Proof reading.....	A*	
ELECTROTYPING:		
Molding, finishing, level- ing molds, routing, trimming.....	B*	
Blocking, tinning.....	30	
Electroplating, washing, backing.....	20	
PHOTO ENGRAVING:		
Etching, staging.....	20	
Blocking.....	30	
Routing, finishing, proof- ing.....	B*	
Tint laying.....	A*	
RECEIVING AND SHIPPING..	10	
RUBBER TIRE AND TUBE MANUFACTURING:		
Stock preparation—		
Plasticating.....	20	
Milling.....	20	
Calendering.....	30	
Branbury.....	20	
Fabric Preparation—		
Stock Cutting.....	30	
Bead Building.....	30	
Tube Tubing Machines..	20	
Tread Tubing Machines..	20	
Tire building—		
Solid tire.....	20	
Pneumatic tire.....	50	
Curing department—		
Tube curing.....	B*	
Casing curing.....	B*	

* See reference footnote at end of table.

TABLE 1.—Continued

	<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>		<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>
UBBER TIRE AND TUBE		Storage, packing and ship-	
MANUFACTURING:— <i>Cont'd.</i>		ping.....	10
Final inspection—		SHOE MANUFACTURING	
Tube.....	B*	(RUBBER):	
Casing.....	A*	Washing, coating, mill run	
Wrapping.....	20	compounding.....	10
Warehouse.....	5	Varnishing, vulcanizing,	
MECHANICAL RUBBER		calendering, upper and	
GOODS:		sole cutting.....	30
Stock preparation—		Sole rolling, lining, mak-	
Plasticating.....	20	ing and finishing pro-	
Milling.....	20	cesses.....	50
Calendering.....	30	SOAP MANUFACTURING:	
Branbury.....	20	Kettle houses, cutting,	
Fabric preparation—		soap chip and powder..	10
Stock cutting.....	30	Stamping, wrapping and	
Hose looms.....	30	packing, filling and	
Molded products.....	B*	packing soap powder..	20
Extruded products.....	30	STAIRWAYS, PASSAGEWAYS..	5
Curing.....	B*	STONE CRUSHING AND	
Inspection.....	A*	SCREENING:	
Boxing.....	20	Belt conveyor tubes, main	
Warehouse.....	5	line shafting spaces,	
SHEET METAL WORKS:		chute rooms, inside of	
Miscellaneous machines,		bins.....	5
ordinary bench work..	20	Primary breaker room,	
Punches, presses, shears,		auxiliary breakers un-	
stamps, spinning, me-		der bins.....	5
dium bench work..	20	Screens.....	10
Tin plate inspection...B*	C*	STORAGE BATTERY MANU-	
SHOE MANUFACTURING		FACTURING:	
(LEATHER):		Molding of grids.....	10
Cutting and stitching—		STORE AND STOCK ROOMS:	
Cutting tables.....	20	Rough bulky material...	5
Marking, buttonholing,		Medium or fine material	
skiving, sorting,		requiring care.....	10
vamping and		STRUCTURAL STEEL FABRI-	
counting—		CATION.....	10
Light materials.....	20	SUGAR GRADING.....	30
Dark materials.....		TESTING:	
Stitching—		Rough.....	20
Light materials.....	50	Fine.....	30
Dark materials.....	B*	Extra fine instruments,	
Making and Finishing—		scales, etc.....	A*
Stitchers, nailers, sole		TEXTILE MILLS (COTTON):	
layers, welt beaters		Opening, mixing, picking,	
and scarfers, trim-		carding and drawing... 10	
mers, welters, last-		Slubbing, roving, spinning 20	
ers, edge setters,		Spooling, warping on	
sluggers, randers,		comb.....	20
wheelers, treers,		Beaming and slashing on	
cleaning, spraying,		comb—	
buffing, polishing,		Gray goods.....	20
embossing—		Denims.....	B*
Light materials.....	30		
Dark materials.....	50		

* See reference footnote at end of table.

TABLE 1.—Continued

	<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>		<i>Minimum Footcandles in Service Measured 30 inches above the Floor</i>
Inspection—		WOOLEN:	
Gray goods (hand turning).....	50	Carding, picking, washing, combing.....	15
Denims (rapidly moving).....	A*	Twisting, dyeing.....	15
Automatic tying-in, weaving.....	B*	Drawing-in, warping....	A*
Drawing-in by hand.....	A*	Weaving—	
Weaving.....	25	Light goods.....	25
		Dark goods.....	50
AND RAYON MANUFACTURING:		Knitting machines.....	20
Soaking, fugitive tinting, and conditioning or setting of twist.....	10	TOBACCO PRODUCTS:	
Winding, twisting, rewinding, and coning, quilling, slashing.....	30	Drying, stripping, general	10
Warping (silk or cotton system) on creel, on running ends, on reel, on beam, on warp at beaming.....	50	Grading and sorting.....	A*
Drawing-in—		TOILETS AND WASH ROOMS	10
On heddles.....	A*	UPHOLSTERING—AUTOMOBILE, COACH FURNITURE.	20
On reed.....	A*	WAREHOUSE.....	5
Weaving—		WELDING.....	30
On heddles and reeds..	10	WOODWORKING:	
On warp back of harness.....	20	Rough sawing and bench work.....	15
On woven cloth.....	30	Sizing, planing, rough sanding, medium machine and bench work, glueing, veneering, cooperage.....	20
		Fine bench and machine work, fine sanding and finishing.....	50

* Lighting recommendations for the more difficult seeing tasks, as indicated by A, B, and C in the foregoing table, are given in the following:

GROUP A.—*These seeing tasks involve (a) the discrimination of extremely fine detail under conditions of (b) extremely poor contrast, (c) for long periods of time. To meet these requirements, illumination levels above 100 footcandles are recommended.*

To provide illumination of this order, a combination of at least 20 footcandles of general lighting plus specialized supplementary lighting is necessary. The design and installation of the combination systems must not only provide a sufficient amount of light but also must provide the proper direction of light, diffusion, eye protection, and insofar as possible must eliminate direct and reflected glare as well as objectionable shadows.

GROUP B.—*This group of visual tasks involves (a) the discrimination of fine detail under conditions of (b) a fair degree of contrast (c) for long periods of time. Illumination levels from 50 to 100 footcandles are required.*

To provide illumination of this order a combination of at least 20 footcandles of general lighting plus specialized supplementary lighting is necessary. The design and installation of the combination systems must not only provide a sufficient amount of light but also must provide the proper direction of light diffusion, eye protection, and insofar as possible must eliminate direct and reflected glare as well as objectionable shadows.

GROUP C.—*The seeing tasks of this group require the discrimination of fine detail by utilizing (a) the reflected image of a luminous area or (b) the transmitted light from a luminous area.*

The essential requirements are (1) that the luminous area shall be large enough to cover the surface which is being inspected and (2) that the brightness be within the limits necessary to obtain comfortable contrast conditions. This involves the use of sources of large area and relatively low brightness in which the source brightness is the principal factor rather than the footcandles produced at a given point.

quired minimum. In locations where the dirt will collect rapidly and where adequate maintenance is not provided, the initial value should be at least 50 per cent above the minimum requirement.

Where safety goggles are worn, the light reaching the eye is likely to be materially reduced and the general level of lighting should, therefore, be increased accordingly in such locations.

In addition to the foregoing table of recommended minimum standards, Table 2 presents the recommended minimum illumination for many of the war production activities not specifically included in Table 1.

NOISE

There is both practical and experimental evidence to indicate that noise produces fatigue, impaired hearing, neuroses, decreased efficiency, and emotional disturbances.¹⁹ Noise levels of 90 decibels (intensity of noise in an airplane) and higher have been found by experience to be harmful to the human ear.²⁰ Exposure to prolonged noise at lower levels, including the intensity of many occupational noises, is also harmful.²¹

As a guide in the evaluation of a noise problem, it is well to know that the intensity of noise near an airplane with motor running is about 95 decibels; in a New York subway it is about 80 decibels; in a large stenographic room it is about 70 decibels; and the intensity of sound in usual conversation varies from 35 to 70 decibels. Intensity alone is not the deciding factor, however. Of equal importance is the nature of the operation, and whether the noise is continuous or interrupted. For example, the average conversation of workers does not interfere with other workers in a machine shop but any conversation interferes with occupants of a library. Similarly a carpenter hammering and sawing does not affect the normal working of other nearby carpenters, but would reduce very much the efficiency in a room where stenographic work is being performed.

To reduce or eliminate the production loss resulting from noise, it is necessary in many industries to reduce the intensity of noise exposures as far as is feasible with good engineering practice. Noise may be prevented, or removed from the workers, by one or more of the following methods: (1) elimination of noise at its source, (2) isolation of noisy operations, (3) reduction of noise by sound insulation, and (4) the use of personal protective devices against noise.

TABLE 2.—RECOMMENDED MINIMUM STANDARDS OF ILLUMINATION FOR WAR PRODUCTION AND ASSOCIATED ACTIVITIES. (The Footcandle Values are Average in Service and Represent Order of Magnitude Rather than Exact Levels.)

	<i>Minimum Footcandles in Service</i>		<i>Minimum Footcandles in Service</i>
AIRPLANE MANUFACTURING:		Mechanical furnaces, generators and stills, mechanical driers, evaporators, filtration, mechanical crystallizers...	
Stock parts—			10
Production.....	50	Tanks for cooking, extractors, percolators, nitro-	15
Inspection.....	A*		
Parts manufacturing—		PRECISION WAR EQUIPMENT:	
Welding, drilling, riveting and screw fastening.....	30	Assembly and adjustment of range finders, binoculars, periscopes, timing equipment, gun sights, electronic devices, torpedo mechanisms, etc.....	A*
Spray booths.....	30	PROTECTIVE INDUSTRIAL LIGHTING:	
Sheet aluminum layout and template work; shaping and smoothing of small parts for fuselage, wing sections, cowlings, etc....	50	General.....	0.2
Sub-assembly—		Vulnerable areas.....	1
Landing gear, fuselage, wind sections, cowlings and other large units.....	30	SHELL LOADING PLANTS:	
Final assembly—		Fuse and booster manufacturing.....	50
Placing of motors, propellers, wing sections and landing gear; mounting of guns and other large equipment.....	30	Inspecting, cleaning and spraying of shell forging.....	30
Inspection of assembled ship and its equipment.....	B*	Loading of shells, bombs, mines and depth charges—	
Machine tool repairs...	A*	Hand.....	B*
ARTILLERY MANUFACTURING:		Automatic.....	30
Forging and casting of gun barrels and mounts	10	Cleaning and inspection	30
Machining and grinding of gun barrels, breeches, mounts and carriages..	30	Assembly of shells, bombs, mines and depth charges	50
Measuring and testing of parts; barrel boring; machining and assembly of range adjusters, and firing mechanisms.	B*	Packing and boxing, storage	10
General assembly.....	50	SHIPYARDS:	
CONSTRUCTION—GENERAL:		General.....	5
Excavation.....	2	Ways and fabrication areas	10
Exterior.....	5	TANK MANUFACTURING:	
Indoor.....	10	Assembly line	B*
EXPLOSIVES:		Frame assembly.....	20
Hand furnaces, boiling tanks, stationary driers, stationary and gravity crystallizers...	5	Body manufacturing—	
		Parts.....	20
		Assembly.....	20
		Finishing and inspecting.....	A*

* Same as for Table 1.

Elimination of Noise at Its Source

The causes of much of the noise in industry are faulty design of machinery, worn machine parts, improper machine mounting, improper location of machines, and carelessness in operating machinery. While it may be expensive in some cases to eliminate these sources of noise, it is frequently a profitable investment over a period of years. Silent operation may be accomplished by (1) replacing worn parts early, (2) using well balanced parts, (3) mounting machinery and guards so that they will not vibrate, (4) keeping moving parts well oiled, (5) having direct or belt drive in place of open gears, or using nonmetallic gears where gears are necessary, and (6) mounting machinery on appropriate bases. A good example of an operation wherein noise has been effectively reduced is that of pressure riveting or welding in place of pneumatic riveting.

Isolation of Noisy Operations

Noise-producing machinery frequently requires only one or two operators, but is so located that many workers are exposed to the noise. Operations of this type should be isolated in well-insulated enclosures so that only the operators are exposed to the noise. Likewise, noisy motors and gears can frequently be housed in sound insulating enclosures to reduce the workers' exposure. Those workers who must remain near the noise may be protected by means of suitable ear protectors or may even be isolated from the noise in well-insulated chambers or rooms which are adequately ventilated. An excellent example of noise prevention by this method is that of testing airplane motors in which the motor test rooms are so well insulated that little noise escapes from the enclosure.

Reduction of Noise by Sound Insulation

Where a large part of the noise in a room or building is caused by reflection of the noise back and forth between the walls, ceiling, objects, and floors, a great reduction can be accomplished conveniently by covering as much of the reflecting surface as possible with suitable sound absorbing materials. An example of this method is the application of sound absorbing materials to the ceiling, and sometimes the walls, of air-conditioned office spaces.

Personal Protective Devices

Where one of the preceding methods is not applicable, or adequate, or does not protect all of the workers, cotton plugs or some of the commercial ear protectors²² may be used to reduce the effect upon the exposed workers. Some of these protective devices reduce the intensity of severe noises appreciably; at the same time, however, they permit the hearing of conversation and thus do not create the safety hazard which would exist if conversation could not be heard.

RADIANT ENERGY

The most important exposure to radiant energy, and one which has been increased many-fold by the war effort, is that of ultraviolet, infra-red, and intense visible light radiation from electric welding arcs. In addition to this important health hazard, there are exposures to infra-red radiation in the heavy metal industries, to roentgen rays and radium emanation in the inspection and testing departments of many industries, to radium, thorium, and other radioactive materials in luminous dial painting and illuminating tube manufacture, to potential hazards from mercury vapor lamps, and to infra-red from drying lamps.

The important exposure, as indicated above, is to the harmful rays produced in welding operations. However, the methods and protective devices for controlling these exposures are so well known and so effective that only a brief summary is necessary. Table 3 gives the protection required for different welding operations.²³

To protect the workers in nearby areas, the welding operations should be shielded as much as possible by means of suitable permanent or portable shields placed about the operation. On the other hand, the welding operation should not be enclosed to such an extent that a serious health hazard to the welder is produced by the reduced ventilation. See *Welding*, Chapter 11.

For continuous exposures to infra-red radiation in the heavy metal processing industries, permanent shields and barriers, as well as protective goggles and helmets, will serve adequately. Spot cooling, if practicable, is helpful to keep such workers comfortable. See *Air Conditioning*, Chapter 21.

X-ray testing equipment used in the inspection of materials presents a potential exposure to radiant energy which is readily controllable. All X-ray equipment should be so shielded or en-

closed by lead that none of the roentgen rays will escape into the room. Where this control is not adequate, protective clothing may be used but it is better to shield the machine properly. Frequent inspections are necessary to guard against any leaks which may result in serious consequences.

The radiation emitted by radium employed in material inspection is more difficult to control than roentgen rays. While lead sheathing around the radium reduces the intensity of the rays somewhat, depending upon the thickness of the lead, it does not eliminate the hazard entirely unless the lead casing is too thick to be practicable. The method of preventing serious

TABLE 3.—PROTECTION REQUIRED FOR WELDING OPERATIONS

<i>Operation</i>	<i>Protection</i>
Production welding at a permanent location.....	Permanent shield with proper density light filter; helmet or hand shield with proper density light filter; or goggles with proper density lens.
Working in the vicinity of a welding operation.....	Goggles or spectacles with No. 3 or No. 4 shade lens.
Light gas cutting and welding, and light electric spot welding.....	Goggles or spectacles with No. 5 shade lens.
Gas cutting, medium gas welding, arc welding up to 30 amps.....	Helmet, shield or goggles with No. 6 shade filter glass.
Heavy gas welding, arc cutting, and welding between 30 and 75 amps.....	Helmet, shield or in some cases goggles with No. 8 shade filter glass.
Arc welding and cutting between 75 and 200 amps.....	Helmet or shield with No. 10 shade filter glass.
Arc welding and cutting between 200 and 400 amps.....	Helmet or shield with No. 12 shade filter glass.
Arc welding and cutting above 400 amps.....	Helmet or shield with No. 14 shade filter glass.

health effects in this instance is to use as little radium as possible, to enclose it in a lead container, and for the operator to remain as far away as possible from the source of energy. The desired combination of these three factors is given in a chart commonly known as the Failla Radium Protection Chart. This chart is presented in the reference cited,²⁴ where complete information on radium protection may be found.

The war effort and the manufacture of new types of lighting tubes have increased tremendously the number of workers exposed to radioactive materials. The control measures are similar to those given in the preceding paragraph for radium except that the amounts of radioactive materials handled are much less and the protective measures may be relaxed accordingly. Luminous

dial painting is covered in detail under *Luminous Dial Painting* in Chapter 11 and the information cited²⁵ is applicable to all exposures of this nature.

Mercury vapor lamps present potential exposures to ultra-violet radiation. The potential health hazard may be eliminated by employing a different type of illumination. Where this is not feasible, frequent inspection should be made to determine whether a hazard exists and if it does, the offending lights should be screened to prevent the ultraviolet rays from reaching the workers.

Infra-red radiation from drying lamps is usually limited to the drying enclosure and presents no significant health hazard as a rule, since no workers are inside the drying enclosure for any length of time.

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CHAPTER 21

HEATING, VENTILATING, AND AIR CONDITIONING

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EVEN though heating, ventilating, and air conditioning within an industry are closely related and interdependent, they will be discussed individually in this chapter for the sake of convenience and clarity.

HEATING

The atmosphere in industries is heated for one or both of the following reasons: (1) the comfort of the workers, and (2) the requirements of the operations or processes. Since the problems brought about by the second of these items are covered elsewhere—see *Radiant Energy* in the chapter immediately preceding, and *Air Conditioning* in this chapter—this section will be limited to the first item, namely, the comfort of the workers.

Factors Determining Temperature

The human being if properly fed and clothed will experience little or no discomfort in atmosphere as cold as 30° or 40° effective temperature,* or if exposed to large temperature changes. The important factors to be considered in determining what temperature should be maintained in places of employment are: (1) degree of activity of the workers, (2) nature of the operation, (3) heating cost, (4) availability of fuel, and (5) accident frequency.

Degree of Activity of the Workers.—Those occupations which require heavy muscular exercise may be performed in very low temperatures, even out-of-doors in winter, without serious discomfort to the worker, while those occupations which are sedentary in nature require warm surroundings if the employee is to be comfortable. The usual recommended effective temperature for sedentary employees during the heating season is 66°. As the degree of activity of the employees increases, the necessary minimum temperature decreases to a value of about 35°, or lower for strenuous work.

* Effective temperature is an empirically determined index of the degree of warmth perceived on exposure to different combinations of temperature, humidity, and air movement.

Nature of the Operation.—Many tasks are crude and of such nature that only the face or eyes of the worker need be exposed. The body as a whole can be well clothed and the workers at such tasks will be comfortable in low temperatures. Other more refined tasks, many of which require considerable skill, or freedom of movement, limit the amount of clothing which may be worn, and a higher temperature must be maintained to keep the worker comfortable and to obtain the best working efficiency. Where workers must handle metal objects or have their hands frequently in liquids such as cutting oils, it is necessary that a comfortable room temperature be maintained, say, 65° to 70°. The efficiency of the operator will obviously decrease rapidly if his hands become cold on a job requiring nimble fingers for the careful selecting or placing of parts.

Heating Cost.—In the colder northern climates the cost of heating is an important item in the cost of operation. Consequently, it is not infrequent that lower operating temperatures are maintained than in the warmer climates. This does not necessarily cause the discomfort indicated by the lower temperature since the natives of the colder areas acclimate themselves to these lower temperatures.

To keep down the cost of fuel and the resulting cost of operation in cold climates, it is necessary that temperatures as low as are consistent with comfort and efficiency be maintained.

Availability of Fuel.—In the past it has been the practice in most industries to maintain operating temperatures of 60° to 70° (effective temperature) and even considerably higher for sedentary workers. Other than the cost of the fuel, there was no serious objection to this procedure even for strenuous work since it has been shown that the ability to do hard work is fairly constant up to an effective temperature of about 70° to 75°. Above 75°, however, the ability to do hard work decreases rapidly. However, to conserve fuel the operating temperatures in industry should be no higher than is necessary to maintain comfort and efficiency, about 65° effective temperature for sedentary workers to as low as 35° or less for the very active occupations.

Accident Frequency.—Data are available to indicate that the accident frequency rate is lowest when the operating temperature is about 67° F. and rises sharply when the temperature moves above 72°, and below 62° F.⁴ Consequently, the temperature should not be allowed to fall too low lest the saving in fuel cost be nullified by the loss in efficiency.

From the above considerations, it is apparent that much can be done to conserve fuel by the careful selection of the proper operating temperature and the maintenance thereof. However, before deciding on substantially lower operating temperatures than has been the practice in the past, unless fuel is not available, thorough consideration must be given to the possible increase in the accident frequency and decrease in working efficiency. Even where an adequate supply of cheap fuel is available, the operating temperatures should not be permitted to exceed about 70° effective lest the efficiency of the workers decrease and their accident frequency increase.

Heating Methods

The various methods of heating workrooms are too well known to warrant discussion. However, the rapid building program and some of the unusual heating problems brought about by the war emergency have resulted in changes and modifications in heating methods which are of importance.

The trend in most of the newer buildings has been toward *unit heaters*, since this method eliminates practically all ductwork other than air intakes, and usually results in lowest first cost consistent with excellent operating results. The projection type using propeller fans appears to be favored for buildings of low and moderate ceiling height, whereas with high ceilings or for applications requiring long blows, the centrifugal fan heat diffuser is favored. Direct gas fired heaters have been used in several instances.

With unit heaters the air may be entirely recirculated, partially recirculated, or taken entirely from the outside, depending upon the existing circumstances. These systems have proved very satisfactory, and have many advantages over other systems since, among other things, they (1) are easy to install, (2) are inexpensive, (3) occupy less space, (4) provide mechanical ventilation, (5) may be used for summer cooling, and (6) are very flexible.

Spot heating may be used to advantage in those industries or workrooms where relatively few workers occupy a large space if the processes do not require that the entire room be heated to the usual indoor temperature of about 66° effective. Here, also, the unit heaters serve very well to keep the temperature of the atmosphere in the vicinity of the workers only up to about 66° effective.

VENTILATING

The major reason for ventilating most industries is to provide respirable air for the workers. This involves two distinct considerations: (1) supplying the oxygen needed by the workers, and removing the carbon dioxide, odor, and in some cases heat and water vapor produced by them, and (2) removing or diluting the atmospheric contaminants produced by the processes and operations. Item 2 has been covered in Chapter 11 and only item 1 will be discussed in this section.

Factors Determining Ventilation Rate

The amount of air respired by human beings varies between about 0.25 cubic feet per minute (c.f.m.) while reclining to as much as 2 c.f.m. or more while engaged in strenuous exercise. In the instance of an office worker or other sedentary person breathing about 0.5 to 0.75 c.f.m. the minimum ventilation rate required to keep the carbon dioxide or oxygen from attaining unsatisfactory levels is about 4 c.f.m. or less. However, it has been shown that higher ventilation rates are required to keep the body odor from attaining objectionable concentrations.⁵ The amount of ventilation required to control the odor is influenced by the amount and type of space occupied by each occupant and varies from 7 to 25 c.f.m. for sedentary workers.⁶

Natural Ventilation

With the exception of those buildings having solid walls and roofs the usual concentration of workers in work spaces is not sufficiently high to cause concern during the heating season inasmuch as the amount of air leakage around doors and windows and the air removed or supplied by ventilating systems employed for the control of air contamination is more than adequate. Where natural ventilation only is available, the minimum operable window area should be in accordance with the following values:⁷

MINIMUM OPERABLE WINDOW REQUIREMENTS FOR NATURAL VENTILATION

<i>Type of Work Space</i>	<i>Per cent of Floor Area Served</i>
Workrooms	8
Offices	8
Eating places and kitchens	8
General storerooms	2
Locker rooms	5
Toilet rooms	5

In large enclosed work spaces occupied by a small number of workers, the air within the occupied space should be circulated mechanically to prevent unsatisfactory atmospheric conditions in the immediate vicinity of each occupant.

Mechanical Ventilation

Heating Season.—As a rule, mechanical ventilation is needed in office buildings, kitchens, cafeterias, and toilet, locker and shower rooms, and it is always needed in enclosed work spaces and blacked-out buildings. The amount of outside air supplied to occupied rooms should in no case be less than 10 c.f.m. per occupant. The following data will serve as a guide in determining the minimum ventilation rate under different conditions of crowding;⁶ it is to be noted, however, that these data pertain only to sedentary workers and the ventilation rate must be increased accordingly for the more active occupations:

MINIMUM OUTDOOR REQUIREMENTS TO REMOVE OBJECTIONABLE BODY ODORS FOR SEDENTARY ADULT WORKERS

<i>Air Space per Person (Cubic Feet)</i>	<i>Outdoor Air Supply per Occupant (Cubic Feet per Minute)</i>
100.....	25
200.....	16
300.....	12
500.....	7

Unit heaters with only partial or no recirculation provide very satisfactory ventilation for large buildings even if blacked out. For office spaces the central system of ventilation is most common although unit heaters supplying outside air are satisfactory.

In northern climates or where fuel is not available, it is advisable not to waste heat by excessive ventilation. In fact, for blacked-out buildings where the worker population is fairly high, consideration should be given to the decrease in ventilation rate which may be effected by recirculating an unusually large percentage of the air through carbon filters to remove the odor so that less outside air is needed and the heat loss is decreased accordingly.

Cooling Season.—During the hot season, very high ventilation rates are desirable to keep the employees cool and thereby increase their working efficiency. Obviously, air conditioning, as discussed later, is the preferable method for cooling work spaces

but where it is not available, a real contribution can be made to the comfort and efficiency of the worker by maintaining high ventilation rates. Even at the ventilation rate of 30 c.f.m. per occupant, the air temperature will be increased as much as 5° to 7° F. by the heat produced by the workers. Consequently, the summer ventilation rate should be as high as feasible and the rate of air movement within the work space should be several hundred f.p.m. to cool the occupants by rapid evaporation of the perspiration.

General Considerations.—Air of a temperature substantially different from that of the room should be mixed well with room air before it reaches the occupants. The outside air intakes to mechanical ventilation systems should be located at points where the air is not likely to be contaminated, or should be provided with suitable filters to insure that the air supplied to work spaces will be uncontaminated.

Toilets, kitchens, cafeterias, and locker and shower rooms should be provided with mechanical ventilation usually of the exhaust type and none of this air should be recirculated.

Garages should be provided with at least 7500 cubic feet of air per minute for every car estimated to be in operation at a given time and in any case not less than 4 air changes per hour unless the exhaust gases from the operating motors are discharged directly to the outside, in which case the ventilation rate may be reduced accordingly.

AIR CONDITIONING

The term *air conditioning* in its broadest sense implies control of any or all of the physical or chemical qualities of the air. However, the term *comfort air conditioning* may be defined as the process by which simultaneously the temperature, moisture content, movement, and quality of air in enclosed spaces intended for human occupancy may be maintained within required limits.

The purpose of air conditioning may be to facilitate, improve, or control production, or to provide comfortable working conditions for the employees, or both. The early experiments and experience with air conditioning were concerned with the control of the atmosphere to obtain an improved product. Even today product control is usually the primary consideration in many industries, excluding office rooms, rather than the comfort of the worker. In fact, the atmospheric conditions required in the man-

ufacturing process are in most instances quite different from the conditions required for comfort. Consequently, air conditioning frequently produces discomfort rather than comfort to many workers.

Conditioning for Product Control

Air conditioning is employed in numerous industries at present to produce an atmosphere which will result in the best product of manufacture or the most economical operation. Examples of such industries are textile, chocolate, meat storage, instrument manufacture, pharmaceutical manufacture, chemical, explosives manufacture, steel manufacture, and airplane manufacture.⁸⁻¹⁰ Frequently the air conditioning is not applied to the entire industry but only to that part requiring the artificial atmosphere.

In some departments of the textile industry, very high humidities are necessary to obtain the best operating conditions. This seldom results in any serious health hazards to the workers if the necessary precautions are observed before entering and leaving the plant. If the humidity is high enough to result in damp clothing at the end of the shift, a complete change of clothing, and suitable locker and shower rooms should be provided by the employer so that all the workers in high humidity may change in a dry place from their street clothes to work clothes at the beginning of the shift, and take a shower and change back to the street clothes at the close of each shift.

In those industries, such as the manufacture of instruments and percussion elements, where a constant year-round temperature of about 70° F. is maintained, the employees are exposed during warm weather to the sudden shock of a relatively cold atmosphere when entering the conditioned space and to that of a hot atmosphere when leaving the plant. In such cases the employees should be provided with suitable clothing to keep them warm during their stay in the conditioned room. If there is an exposure to toxic substances such as would be the case in the manufacture of explosives, the workers should be provided with a complete change of warm clothing; otherwise, only additional clothing such as coveralls need be provided. During the summer the employees should be granted near the close of the shift a short period, depending upon the temperature difference between the inside and outside air, to relax *in the warm atmosphere* and acclimate themselves before rushing to get home as is the case at the close of the work shift. Also, if the temperature difference

is considerable, a slight increase in activity directly *before leaving the cool room* is advisable.

In some industries such as those concerned with hygroscopic substances very low humidity may be desired, whereas in other cases, such as the processing of some explosives or in operating rooms, higher humidities—40 to 60 per cent relative—are needed to avoid the accumulation of static electricity. These conditions seldom present any serious health problem.

Conditioning for Comfort

It has been shown¹¹⁻¹⁴ that the comfort temperature in air-conditioned spaces increases as the outdoor temperature increases. That is, the temperature maintained in air-conditioned spaces during warm weather should not be fixed but should be increased slightly as the outdoor temperature increases. The following data give the recommended indoor effective temperatures for different outdoor conditions:

DESIRABLE INSIDE CONDITIONS IN SUMMER CORRESPONDING TO OUTSIDE TEMPERATURES		
<i>Outdoor Temperature Dry-Bulb (Fahr.)</i>	<i>Indoor Temperature Effective</i>	<i>Dry-Bulb (Fahr.) Approx.</i>
100.....	75	82
95.....	74	81
90.....	73	80
85.....	72	79
80.....	71	77

Until recently, only very few buildings of employment or manufacturing plants were air-conditioned, even though it was known that the comfort and efficiency of the workers were enhanced considerably during the summer months. The reason for this was obviously the cost of air conditioning. Office buildings fared somewhat better owing to the fact that the worker concentration is higher as a rule and air conditioning of such spaces is a better investment. Furthermore, adequate insulation of office buildings is not difficult and the operating cost of air conditioning is not very great. Today air conditioning of very large manufacturing establishments, particularly of windowless or blacked-out construction, is becoming more common.¹⁵⁻¹⁷ The buildings are constructed for air conditioning and the operating cost apparently is not excessive.

There still is considerable speculation regarding the possible favorable influence of air conditioning upon the incidence of respiratory illness. One study in a large office building has indi-

cated that there is no significant difference in the frequency rate of illnesses between occupants of air-conditioned and non-air-conditioned buildings.¹⁸ Others have reported considerable reduction in the illness rate, but conclusive evidence appears to be lacking.¹⁹⁻²² Other studies and observations now in progress will probably remove, when completed, all speculation on this subject.

In those industries where the worker concentration is small or where only a few of the employees are exposed to high temperatures, usually from radiant heat, spot cooling with a blanket of conditioned air at low velocity from an overhead canopy hood produces desirable results at no great cost. In other cases, such as crane operators above large furnaces or in steel mills where the temperature is such that employment is limited to short alternating periods, the work space can be made quite comfortable by enclosing the crane cab and air conditioning it.²³ Where it is impracticable to follow this procedure, the cab operator may be kept comfortable by supplying properly conditioned air to a special uniform which he wears.²⁴ The conditioned air enters the uniform at a convenient place, such as the center of the back, and is wasted at the neck and ankles. Equipment of this type would serve also for other hot operations such as cleaning out hot furnaces.

Likewise air conditioning will aid in the control of dermatitis in those industries where the substances being handled or processed are harmful to the skin, such as tetryl. By air-conditioning these plants in summer, the workers are kept more comfortable and as a result, are not constantly wiping their perspired faces and arms with a handkerchief or sleeve which is grossly contaminated with the toxic substance.

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PART III

THE MANPOWER PROBLEM

CHAPTER 22

MAXIMUM USE OF MANPOWER

Robert H. Flinn, M.D.

THE NEED

THE growing demand of our armed forces is resulting in a rapid depletion of able-bodied workers in industry. With the constantly increasing need for more soldiers and sailors, workers are increasingly difficult to obtain. American industry at present is producing ships, aircraft, tanks, and guns on an unprecedented scale. This rate of production must increase if we are to enable our armed forces and those of our allies to bring the war to a successful conclusion. Consequently, old and outmoded industrial practices in the employment of new personnel must give way to a realistic and modern approach in the matter of placing physically sub-standard workers at productive work in order to attain maximum production for the war effort with limited manpower. This same consideration also applies to the fullest use of women and elderly men.

THE PROBLEM

It has been estimated* that as many as eight million men, and about as many women of working age are suffering from some degree of physical handicap that ordinarily would make it difficult and in some instances impossible for them to obtain employment. Of these eight million handicapped males possibly almost seven million are capable of working without rehabilitation. Many of these men now hold jobs but should they lose them or change employment there is always the possibility that they will be rejected for other similar jobs because of their physical handicap. Moreover it has been estimated that approximately one

* Dorn, H. F., and Karpinos, B. D.: Unpublished data based on the National Health Survey.

million men of the eight million need rehabilitation before they can be employed in an occupation commensurate with their education or ability, probably even then requiring selective placement. There are an estimated 350,000 men so seriously impaired that even after rehabilitation most of them can be safely employed only in sheltered work of some kind. Nearly 75 per cent of this last group were from 45 to 65 years of age so that their limited possibility of employment was a combination of age and disability.

Industrial Hygiene Field Investigations

Recent Public Health Service surveys of 9 new and 1 old large munitions plants show that the *average* rejection rate for applicants reaching physical examination was 7.6 per cent. These rates based on a total of 84,000 examinations showed wide variation and ranged from 0.7 to 16 per cent. The rates of rejection would have been higher in some instances had there not been a preliminary weeding out of presumably unfit applicants by the plant's employment department in the selection interview, by the local employment offices when participating in the selection, and by certain handicapped persons with a feeling of futility in applying to large employment departments. From the 5 plants where detailed figures were available, the following reasons for rejection were given:

Reason for Rejection	Number of Rejections	Per Cent of Rejections
Hernia.....	737	21.8
Hypertension.....	674	19.9
Defective vision.....	507	15.0
Chest pathology, including tuberculosis.....	323	9.5
Orthopedic defects.....	268	7.9
Skin and varicosities.....	260	7.7
Heart disease.....	107	3.2
Genito-urinary.....	79	2.3
Mental and nervous.....	78	2.3
Defective hearing.....	51	1.5
Albuminuria.....	48	1.4
Glycosuria.....	30	0.9
Positive serology.....	29	0.9
Defective teeth.....	25	0.7
Varicocele and hydrocele.....	20	0.6
Active syphilis.....	6	0.2
Gastro-intestinal disorders.....	5	0.1
Miscellaneous.....	137	4.1
Total.....	3,384	100.0

It is noteworthy that practically all the rejections for chest pathology occurred in the 2 plants where routine X-ray microfilms were being made of the chest. This suggests that this procedure, although beneficial for screening out suspicious pulmonary infections, may work an injustice on the applicants for employment. Reading these films too closely and not doing follow-up diagnostic work results in excessive numbers of rejections.

It is apparent from these data that such handicaps as hernia, hypertension, defective vision, and orthopedic defects made up two-thirds of all rejections. Also, from close scrutiny of this list, the lack of seriousness of many of these disabilities is outstanding, taking into due consideration the varying degrees of actual disability always found in each classification. It appears evident that the great majority of these workers denied employment could have been placed by the coordinated action of the medical, safety, and personnel departments at jobs they could do safely and efficiently, thereby increasing national manpower and production. The fact that three of these plants averaged only 1 per cent rejections, as compared with four others in the group which averaged 14 per cent rejections, indicates that many employers and physicians are already finding it practicable and advantageous to place applicants at productive work rather than relegating them to the class of unemployables. This has also been shown in a survey of 2064 industrial establishments by the Committee on Healthful Working Conditions of the National Association of Manufacturers. This committee found that the most representative rejection rates fell between 2 and 3 per cent, and that 28 per cent of the plants rejected less than 1 per cent of the applicants.¹⁷ On the other hand, many other plants were rejecting an excessive proportion of applicants as 15 per cent of the plants rejected from 6 to 10 per cent of their applicants and 7 per cent rejected from 11 to 50 per cent.

New Jersey Experience

Dr. Henry H. Kessler, Medical Director of the New Jersey Rehabilitation Clinic, who has had lifelong experience in this field, has stated as follows concerning the employability of the handicapped¹⁰ (*italics supplied*) :

It is more important to evaluate the defect from a functional point of view as *static* or *dynamic*. The loss of a finger, short stature, missing teeth, hernia, some visual defects, leg shortening, leg amputation, the paralysis of a single muscle group, deep scars of bone or soft parts are *stationary* defects

and rarely affect the individual's capacity to work. Accommodation to these static defects may be sufficiently adequate to make the individual fully productive. The leg amputee can perform seated or standing work; paralysis of an arm may still permit the individual to work as a draftsman or as a salesman. Tuberculosis, arthritis, and similar systemic and progressive diseases are *dynamic* in that they affect the entire body, and by their influence on perceptual, intellectual and motor functions reduce productivity. Rejections should be based on the presence of *disease states* and not on *static defects*, except where job analysis in a specific vocation indicates an unusual physical requirement.

. . . a man's capacity to work is not the result of his anatomical make-up. His native ability, his personality and his training all contribute to his productivity. Anderson's study of more than 4,000 physically handicapped individuals engaged in 635 different types of work shows the versatility of these individuals. In an examination of more than 100,000 accidental injuries for the New Jersey Workmen's Compensation Bureau, it was rare for a man to change his occupation even in instances where a functional disability as high as 75% of total work capacity was estimated. . . .

Employers further rationalize their reluctance to employ the physically handicapped because they believe that their defects make them accident prone. There are enough data on hand to disprove this false contention. For example, in Connecticut, the Workmen's Compensation Law contains a waiver clause by virtue of which the employee is permitted to waive any rights to compensation for additional injuries, on account of physical disabilities. Ohio, Wisconsin and Massachusetts permit certain physically handicapped workmen to waive compensation. From 1,000 to 1,500 of these waivers are signed per month, yet despite this large number of workers with physical defects, the incidence of accidental injury among this waiver group is no higher than that of the normal working population.

What has been said about the physically handicapped may also be applied to the so-called over-age employee. Swiss studies show that the incidence of industrial accidents is much less among those aged 40 to 50, than among those from 20 to 40. Because of the powerful psychosocial prejudice on the part of industry and society toward the physically handicapped and over-age employee, ordinary educational methods have proved futile in finding a place for them in our national industrial life.

Thus we see a vast reservoir of man power annually lost to the national economy. This large number of persons handicapped by minor disabilities, but possessing great potentiality for functional performance are being rejected for military service and condemned as undesirable by industry.

GENERAL CONSIDERATIONS

From a careful consideration of all these factors, it is believed that our national interest demands the fullest use of the large supply of manpower lying hidden in the millions of persons with physical handicaps. The proportion of these who cannot do productive work is relatively small. Because of the great variation in occupations and the varying kinds and degrees of disabilities, a manual obviously cannot be formulated that will show exactly what a man with a given handicap can do efficiently and safely.

If the problem is treated on an *individual* basis with serious and intelligent consideration by the physician and employment personnel, the productive man hours available to industry can be greatly increased.

The *basic questions* to be answered in employing a man with a given handicap should be:

1. What *job* can he work at productively?
2. Can he do this job without being a *hazard* to himself or others?
3. To what extent is medical *supervision* necessary?

Job Analysis

In order that the physical capacities of the worker with a physical defect may be *accurately related* to the physical requirements of a job, it will be necessary to have available an analysis of each job, particularly of those factors of the job which relate to physical demands and working conditions. The job analysis will need to cover such physical-demand factors of the work as walking, standing, stooping, lifting, using feet and hands, seeing, talking, hearing, and environmental conditions such as temperature and temperature changes, and noxious gases, dusts, and fumes. Recent observation has indicated that while some plant personnel departments and managing officials have an adequate knowledge of job requirements, many others are surprisingly lacking in current and accurate information of the actual physical requirements of their jobs.

The temperamental characteristics of the applicant should always be considered with relation to the job requirements, and applicants who are emotionally unstable should not be placed at work offering unusual mental stress.

The U. S. Employment Service through its regular placement channels is finding some opportunities for placement of applicants with major as well as with minor defects, particularly in local plants. The channels for clearance to employers in other communities are generally closed to placement of applicants unable to pass a fairly rigid physical examination. To facilitate placement in occupations which are suitable and safe, the U. S. Employment Service is making studies of occupations to determine the minimum requirements essential to satisfactory performance.²

Governmental Policy Modified*

In January, 1942, the Medical Director of the U. S. Civil Service Commission described the rapid changing of governmental policy in employing handicapped workers in order to further the war effort.⁷ Each job was being rated as to physical ability required and the present trend in setting physical standards was to give handicapped persons every possible opportunity to compete for employment. Examinations were opened in many positions to persons with a high degree of refractive error, to deaf-mutes, to those with defective hearing, orthopedic defects, and properly treated syphilis. Those with arrested tuberculosis were admitted to examinations where the duties were not too arduous, the disease had been arrested for one year, and the general health was good.

More recently, the Commission, through its War Service Regulations, has further liberalized its policy on employment of persons with syphilis, arrested tuberculosis, diabetes mellitus, and persons with other physical handicaps, although the final responsibility for determining the physical fitness of the prospective appointee for the specific job rests with appointing officials.⁸ The Commission's medical officers and those in the 13 district offices are available for consultation and advisory service on problems relating to physical fitness for employment.

The Commission's statement says, in part:

In keeping with the pronouncements of the War Manpower Commission and the Selective Service System, which encourage the use of physically handicapped persons, the Commission is making every effort within its competence to utilize the services of the physically handicapped wherever possible and has issued instructions to the various governmental departments encouraging them to place physically handicapped persons in positions, the duties of which they can perform satisfactorily without being a hazard to themselves or others.

The Medical Division of the Commission and Medical Officers in the District Offices are now in the process of making extensive surveys of positions in the governmental industrial establishments, including arsenals, navy yards, ordnance depots, etc. The purpose of these surveys is to obtain information on the physical fitness standards of the positions and such information will enable the Commission to render advice to appointing officials on the placement of physically handicapped persons in governmental industry. In addition the Commission works in close collaboration with the Rehabilitation Division of the Office of Education, Federal Security Agency, in planning placement activities for the physically handicapped. Success of

* The following article has appeared since this chapter was prepared: Harvey, V. K., and Luongo, E. P.: The Physically Handicapped in Industrial Establishments of the Government. *Jour. Am. Med. Assn.*, 121:100 (January 9) 1943.

the Commission's endeavor in placement activity will depend to a considerable degree on the coordination of rehabilitation training with the Commission's placement activities and policies, and also upon the willingness of appointing officials to utilize wherever possible the services of the physically handicapped and not discriminate against them on the basis of standards which are artificial and not based upon true industrial risk considerations.

It must be borne in mind that the U. S. Government is making these efforts to place handicapped workers in its own industrial establishments despite a liberal compensation law, retirement pensions, and wages and hours prescribed by law.

Rehabilitation of Handicapped Workers

Numerous agencies—Federal, State, and private—have been directing attention to the *vocational* rehabilitation of the relatively small proportion of handicapped workers who need these services before being placed at productive war work. The Director of Vocational Rehabilitation in Pennsylvania has discussed the successful vocational rehabilitation and placement of handicapped workers in Pennsylvania industries, and also, among others, the Ford Company, the Western Electric Company, and the Westinghouse Electric and Manufacturing Company.³¹

According to Banta,² the State Vocational Rehabilitation Services are directing emphasis on preparing their physically handicapped clients for employment in war industries. Increasing use is being made of wartime training classes for short pre-employment courses in machine shop practice and similar instruction which is readily usable in war industrial plants. The number of physically handicapped prepared by the Rehabilitation Services shows notable increases over previous years. Any substantial increase in the numbers of physically handicapped served by either the U. S. Employment Service or the State Vocational Rehabilitation Services is dependent upon expansion of the facilities of the two agencies. Proposals have been submitted to provide for a redefinition of the vocational rehabilitation program and for expansion of the facilities. Plans for this expansion are dependent upon legislative enactments. The plans as prepared provide for *physical* as well as *vocational* rehabilitation of physically handicapped persons whose employability can be improved by minor physical restoration, artificial appliances, guidance, or training.

Unfortunately, only isolated efforts have been made for the *medical* or *surgical* rehabilitation of handicapped persons such as described by Sawyer.^{22, 23} Several other articles describing

these efforts appear in the list of references. According to Kessler,¹⁰ only one State, New Jersey, has emphasized the objective of physical restoration.

The present demand for more and more manpower is resulting in a reappraisal of methods for effectively accomplishing such aims. This should result in a concerted effort to solve the problem. Federal and State legislative enactments are in process in this connection.

One method might well be the lending of sufficient funds from the Federal or State governments to provide for surgical and hospital care, to be repaid by the rehabilitated worker after finding employment. Such a policy would be far more economical in favorable instances than the State's supporting the handicapped worker in idleness.

RECOMMENDED POLICIES

Selective Placement

The following general principles are recommended as a basic policy in solving the problem of selective placement. These principles are based on personal observation of the best practices in many modern industrial establishments, and from the experience of other investigators.^{16, 9} This list is by no means complete but outlines examples of recommended procedure under 3 heads:

1. *Handicaps suitable for immediate placement.*

- (a) Symptomless hernia, varicocele, hydrocele, or varicosities.
- (b) Defective vision due to refractive errors.
- (c) Impaired hearing or deafness.
- (d) Arterial hypertension, asymptomatic.
- (e) Heart disease, compensated.
- (f) Orthopedic defects, including amputations and ankyloses.
- (g) Dental defects.
- (h) Simple glycosuria or albuminuria.
- (i) Blindness.
- (j) Arrested pulmonary tuberculosis.
- (k) Latent syphilis, while taking treatment.

As noted previously, this list comprises the great majority of the reasons for rejection in many plants.

2. *Handicaps calling for temporary rejection until treated satisfactorily.*

- (a) Communicable syphilis, until 4 injections are given.
- (b) Acute gonorrhea.
- (c) Acute respiratory diseases.
- (d) Irreducible hernia.
- (e) Painful or prolapsed hemorrhoids.
- (f) Painful varicosities, varicocele, or hydrocele.
- (g) Severe refractive errors.
- (h) Symptomatic arterial hypertension.
- (i) Organic heart disease, symptomatic.
- (j) Clinical diabetes mellitus, unless severe.
- (k) Painful, crippling orthopedic defects.
- (l) Severe skin diseases.

These cases should be put to work as soon as the disability is relieved or controlled. Many will require continued medical supervision. All acute, limited diseases should be included in this classification of those temporarily ill.

3. *Unfit for employment.*

- (a) Active tuberculosis.
- (b) Syphilis of central nervous system.
- (c) Frequent epileptic attacks.
- (d) Severe diabetes mellitus.
- (e) Decompensated cardiovascular disease.
- (f) Psychoses.
- (g) Cancer.
- (h) Active, painful arthritis.
- (i) Any serious active, progressive disease.

Some of these cases could be employed after adequate medical treatment. Others could do useful work in sheltered workshops or in the home.

Job Analysis

The fullest use should be made of the job analyses of the U. S. Employment Service, the U. S. Civil Service Commission, the Rehabilitation Division of the Office of Education, and related State agencies in order that the physical-demand requirements of the job may be taken into account in safely placing a worker with a given handicap. In individual plants the employment personnel should know the *physical requirements of each job* and confer with the examining physician regarding proper placement. The physician should acquaint himself with the job requirements for employees under his supervision, so far as possible. The final criterion for placing handicapped workers should be:

Every person is capable of doing some useful work unless he is ill in the common meaning of the term.

Rehabilitation

Training the handicapped worker to do a new job, or to do the old job satisfactorily despite the handicap, is being done on a fairly large scale. Physical restoration such as reconstructive or reparative surgery, and fitting of prosthetic appliances, eye glasses, or hearing aids, is very valuable and is being done on a limited scale. These activities should be expanded to care for the small proportion but sizable number of disabled workers who cannot be placed directly at useful and suitable work. This expansion of activities will probably require, and should have, Federal support.

CONCLUSION

American industries are producing war materials on an unprecedented scale and must increase their output despite the demand for millions of able-bodied men by the armed services. It has been estimated that there are about 8 million men, and possibly as many women, of working age with some physical handicap or disability that in many instances would adversely affect their obtaining suitable and productive employment. A very large proportion of these persons, perhaps 85 per cent of those not at present employed, can be put to work, by *selective placement*, at jobs they can do efficiently and safely. Many war industries are following this policy and have a bare minimum of rejections, about 1 per cent. In other and often less progressive plants, up to 1 in 5 applicants are being rejected, most of whom could be placed properly at productive work. In view of the serious labor shortage, a policy of high-handed rejection of handicapped workers would appear to give aid and comfort to the enemy. A plan for placing these persons at suitable work will do much to aid war production.

A large proportion of the remainder of the handicapped workers can be placed at productive work after vocational or physical rehabilitation. Efforts to achieve this purpose should be supported on a larger scale by the Federal and State governments and by every other agency or group concerned with war production.

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CHAPTER 23

WOMEN IN INDUSTRY

Hugh P. Brinton, Ph.D.

WAR conditions have brought into operation a complex series of social forces which have made necessary the employment of women in ever-increasing numbers. So long as the war continues this trend will be maintained, stronger and more accelerated in some areas, less marked in others. Gradually the entire country will become more and more aware of the part played by women in the production of war materials and in the provision of essential goods and services required by civilians.

Many of the health problems raised in particular industries because of the influx of women are similar to those which would be produced if an equal number of men had been hired. However, it cannot be denied that certain problems require different treatment when women are involved. The essentials for maintaining the health of industrial workers are the same irrespective of sex, but the differing physiological and social background of women require a different approach in some instances.

This chapter will deal with a few of the outstanding problems which must be recognized by any company wishing to maintain health among women workers. While nearly all of the matters touched upon here are treated in other chapters in greater detail from the viewpoint of all workers, it is desirable to examine separately those changes associated with the employment of women.

THE EMPLOYMENT OF WOMEN

The demand for women workers began before the actual declaration of war. The defense program increased buying power and in consequence new jobs were opened up. These, for the most part, were in occupations traditionally held by women such as retail sales, clerical and service positions, and consumer goods manufacturing. The workers affected were women who are normally a part of the labor market. Gradually, there developed a shortage of qualified male labor in certain highly industrialized areas. Women were taken on by light mass-production industries. Their tasks involved relatively simple, high-speed machine opera-

tion and assembly work, which required dexterity, care and speed with a minimum of strength and craftsmanship. Many of these women had not previously worked in factories. Finally, since December 7, 1941, women have begun to enter jobs in trade, services, transportation, and manufacturing that have customarily been held only by men. When women are hired by such industries they release men for heavier, more exacting factory work or for service in the armed forces.

Following a pattern already well established in England^{1, 2} and Germany^{3, 4} as the war continues women in this country will take over more and more of men's jobs. Assimilation by industry of these millions of new inexperienced women workers inevitably will bring an increased need for industrial health programs. Old standards for jobs suitable for women will be discarded and new ones will have to be established. No definite limits can be set as to what tasks women can do and what tasks they cannot do. Under emergency conditions their sphere of work has broadened tremendously. Careful medical supervision should aid in determining where and under what conditions they can safely be allowed to work.

According to the U. S. Women's Bureau,⁵ the following types of work are performed particularly well by women: (1) work requiring care and constant alertness, good eyesight, and use of light instruments; (2) work requiring manipulative dexterity and speed, but which permits the individual to set her own tempo and to work in a sitting position; (3) work requiring skill but little strength, either in handling parts or setting up machines.

In general it has been found that the most efficient organization of factory work provides that women perform the lighter and less complex tasks while men do the heavier and more complicated work.

Sources of Female Labor

It has been estimated that 14,200,000 women were at work during August, 1942. By the end of 1943 it is expected that at least 5 million additional women will be employed. These will come from the 4 million girls now in school, and the 30 million women who are classed as homemakers. Of the latter group approximately 17 million are 14 to 45 years of age. Of this ostensibly available group the majority have children, and many are living in sections of the country where they cannot readily secure employment.

Before married women with young children are employed in large numbers it is desirable that other sources of female labor be exhausted. A suggested order for employing women without young children is as follows: first, women who have lost employment because of priorities or plant adjustments to war production; second, other unemployed women who are registered with the U. S. Employment Service; third, girls coming from schools and colleges; and fourth, married, widowed, deserted or divorced women without young children. How soon these various classes of women will be needed in industry will differ widely according to *geographic locality*. In some highly concentrated war production areas the problem of women with young children has already presented itself, while in other areas there are still unemployed women without family responsibilities to draw from.

SELECTION AND TRAINING

Procedures in regard to the selection and training of women are in general the same as for men, but in some respects the choosing of new women employees is more difficult.^{6, 7, 32} Information regarding previous related training and experience which forms the usual basis for selecting male applicants is less likely to be available for women, since many of them will be just entering the labor market. Women are said to be more particular about the kind of work they are expected to do and about the people with whom they are to associate. There may be an excessive labor turnover unless prospective employees are made aware of all that is involved in factory work.

In the selection of women some companies use *special tests* of aptitude, intelligence, achievement, finger dexterity, and hand and eye coordination. Other companies rely on oral tests. Still others depend on a skilled interviewer who can ascertain much concerning an applicant's interests, character, emotional stability, intelligence, general adaptability, and home obligations. All possible clues to an applicant's fitness for factory work and her attitude toward it must be thoroughly explored, especially if there is little in her past experience to indicate how she will adjust to a new environment.

Company policies with respect to the selection of women workers may change as the war emergency progresses. Restrictions on the employment of married women and older women will necessarily be relaxed. Moreover, attitudes with respect to minority groups may change. The hiring of female relatives of

present male employees may be stimulated since this increases the labor supply without affecting housing, brings new employees acquainted with the company, and minimizes post-war adjustments.

The successful placement of women requires a *complete physical examination*, at least as thorough as for men. For details of the type of examination recommended see the chapter on *Medical Services*. Equally important is the preparation of a *job analysis sheet* which should include, among others, the following items: the degree of physical exertion required; knowledge or skill required; exposure to moving machinery or other operation hazards; amount of sitting or standing involved in the operation; exposure to toxic dusts, fumes, gases, vapors and mists; degree of eyesight keenness needed; nature of the job, whether individualistic or working with others; and the amount of finger dexterity required. The physical and psychological characteristics of the job and of the woman who is to fill it must be matched if the worker is to be happy and productive.

When a woman employee is hired she should be helped to become *acclimatized* to her new way of life. More than to a man the new world of strange machines, odd noises, and peculiar smells is disconcerting to her. A friendly introduction to plant rules and procedures, and to her supervisors will decrease the amount of time required for her to attain maximum productivity. The plant medical service can help by describing to her the various kinds of health services which are available, the rules and regulations regarding sick leave, and the possible health hazards connected with her job. The best time to inculcate good health habits and safety consciousness is when an employee, whether possessing previous industrial experience or not, is entering upon a new job.

PLANT FACILITIES

When a plant is contemplating the inclusion of women in its labor force certain changes are often necessary in those operations which are to be taken over by women for the first time. For example, the job may have to be reengineered so that machine operation is easier without any heavy lifting or high reaching. The component parts may have to be simplified to reduce the minimum skill requirements for the operation. Working conditions may have to be made less dirty and less noisy. Relocation may be necessary if the job is near a department where there are unpleasant or hazardous dusts and fumes.

Proper seating is desirable for both men and women, but it is especially so for women since they are more likely to show bad effects from standing too long. Factories taking on women frequently discover that all sorts of makeshift and unsafe seating arrangements have come into use. These should be discouraged and the right kind of seat should be provided, adjustable both to the worker and the particular job she is performing. Studies in this country and in England show that good seating has a marked effect in increasing the production of women workers. Two factors must be taken into consideration: first, the seat is so placed that the working material can be reached easily and without strain; and second, that the position taken by the operator is such that the back is straight, without being stiff, and the shoulders and arms can move easily. The worker should sit back in the chair. If the seat has a back rest and a foot rest, the worker should be so placed that she can use them both easily without any strain on the muscles. The industrial physician can aid in reducing fatigue among women workers by explaining to them correct posture and the benefits to be gained from proper seating.

Toilet and rest room facilities are an obvious necessity for all plants employing women. If a company has no facilities because it is beginning to use women, or if a company is employing more women, the securing of adequate equipment under wartime conditions of supply will require much effort. However, it is essential that women have light, airy, and clean rest rooms containing comfortable chairs and beds or couches; an efficient and contented labor force cannot be expected if this matter is neglected.

Washing facilities should be placed in convenient locations and provided with hot and cold water, soap, and individual towels. Cheerfully decorated rooms with such extras as rugs, tables, radio and curtains are appreciated by women. State standards for lavatories and toilets must be met. A detailed account of recommended standards will be found in the chapter on *Plant Sanitation*. According to the experience of some companies the provision of adequate sanitary facilities for women does not amount to a large cost item, but the problem is more frequently that of finding sufficient space.

Restaurants or cafeterias are a generally recognized plant service. Lunches are important for women since they often eat an extremely light breakfast. Women living in furnished rooms have little opportunity for preparing their own lunch, so they are dependent on food service provided by or near the plant. Plants

which now provide meals may anticipate difficulty in feeding all employees if large numbers of new workers are added. Either the lunch hour may be lengthened or eating facilities expanded. The movable lunch wagon does not offer an entirely satisfactory solution, since it does not afford women the needed place for rest and relaxation. Women fail to obtain the full benefit from the lunch period when they eat where they work. Particularly harmful to the health of women is the practice found in some plants of eating on the job without any definite rest period. A more complete account of the need for food service will be found in the chapter on *Nutrition in Industry*.

Medical services and dispensary facilities may require some expansion when women are hired. In the larger plants additional bedrooms will be needed. Some companies have added a woman physician, a trend which is likely to become more evident as male physicians enter army service and the proportion of women among the employees becomes greater. In the smaller plants the presence of women will make more imperative the employment of a full-time registered nurse.

The important topics of *ventilation and lighting* are treated elsewhere for all workers. It is likely that if such facilities are adequate for men, they would be adequate should women be employed.

WORKING CONDITIONS

One of the most pressing problems which is likely to arise with the employment of women in war production plants is the matter of *optimum daily and weekly hours*, and the most satisfactory *shift schedules*. At present maximum output is essential, so that there is naturally some sacrifice of peace time standards for leisure and recreational activities. However, in the instance of all workers, but especially women, it is fallacious to assume that production can be increased indefinitely by lengthening hours. Beyond a certain point it is well known that it is impossible for workers to maintain either the quality or quantity of their output.

Relaxation of Legal Restrictions

Because of the war temporary emergencies are likely to arise in certain establishments which will necessitate the employment of women under standards which are lower than the legal minimum. A committee of the Women's Bureau, U. S. Department

of Labor, made the following recommendations at a meeting held on January 21-22, 1942:⁸

1. Authority to grant temporary modifications of State labor laws be lodged in State departments of labor.
2. Each employer seeking temporary exemption from State labor laws be required to file an application with the labor commissioner.
3. Each application be thoroughly investigated by the labor commissioner to determine whether the need for such an exemption actually exists.
4. No permit granting an exemption be issued to an employer who can maintain labor standards by using available labor supply, or by making adjustments in the organization of his plant.
5. No permit be issued, even though trained workers are lacking, unless the employer make satisfactory arrangements to train or to secure trained workers within a reasonable time.
6. No exemptions be granted to employers not engaged in war work.
7. No permit be issued if the health and welfare of the workers would be endangered thereby.
8. Permits be limited to individual plants and for specified periods of time.
9. Permits be revoked when exemptions are found to be unnecessary to maintain maximum war production.

As of October 1, 1942,⁹ all of the 11 States with laws or orders prohibiting the employment of women at night in manufacturing provide for the exemption of women of 21 years of age or over in war production. Seventeen of the 21 States establishing a maximum work week of 48 hours permit a longer work period for women in war production. Eighteen of the 20 States which require one day of rest in 7 for women workers allow employment for 7 days in war work. In most cases permits are issued only for war production work and for a specified period of time.

Forbidden Occupations

Laws regulating or prohibiting the employment of women in certain occupations are relatively few. Hence the problem of modification to meet war conditions has not assumed much importance. If Pennsylvania and Ohio are excluded because each has a long list of prohibited occupations, there will be found few occupations other than mining or quarrying (15 States) which women are legally prevented from entering. These occupations include tending coke ovens, working in smelters, working as bell hops, work on certain kinds of moving abrasives, work in the manufacture of nitro and amino compounds and the handling of any dry substance containing lead in

excess of 2 per cent, oiling moving machinery, and working between machinery. In only one of the remaining 46 States was each of these occupations found. Three States prohibit the cleaning of moving machinery and 5 States regulate work in core rooms. The lifting or carrying of heavy weights is regulated in 8 States. In all, 26 States have no laws prohibiting the employment of women in specific occupations. However, two of these States and 7 additional ones have laws which in general terms prohibit the employment of women under detrimental conditions. In defining conditions of labor which are dangerous to women such terms are used as "health," "morals," "safety," "potential capacity for motherhood," or "welfare." Current information on laws relating to women may be obtained from the U. S. Women's Bureau.

Hours of Work

In a joint statement signed by representatives of 8 government agencies¹⁰ it was recommended that for both men and women the 8-hour day and 48-hour week approximate the best working schedule for sustained efficiency in most wartime industrial occupations. One day of rest for the individual, approximately every 7, was stated as a universal rule.

Industrial physicians are likely to be called upon for advice with regard to the employment of women at night, the shift schedules best adapted to their needs, and the frequency of shift rotation. Night work for women is not recommended, but the increasing shortage of labor coupled with the desire to operate machinery 24 hours per day makes it unlikely that this can be prevented entirely. If women must work at night certain measures for reducing health dangers are suggested by the U. S. Women's Bureau:¹¹

By Management

1. Making sure the individual is able to work on the night shift. Not all workers are able to take their turns at night-shift work throughout extended periods. While a shift arrangement involving night work is in progress, careful study should be made of effects on the individual, and those not suited to night work should be relieved of the night shift. No employee should work on a night shift if there is a history of anemia, respiratory disease, digestive disease, or nervous disorder.

Women with home responsibilities should not work on the night shift except in a short and definitely limited emergency.

It is inevitable that household duties during the day plus work at night will cause chronic fatigue.

Loss of regular sleep is more serious for young workers who have not attained full growth. Hence, young girls should not be placed on the night shift.

2. Providing time and facilities for a hot and nutritious meal.
3. Preserving the week-end rest.
4. Assuring effective health supervision for night workers.
5. Providing well-trained supervisors for night workers.
6. Providing good lighting, which lessens fatigue and the likelihood of accidents.
7. Giving attention to workers' transportation problems.
8. Paying a differential rate for work at night, thus providing some compensation for the additional strain of night work.

By Workers

1. Spending 7 or 8 continuous hours in bed.
2. Eating a hot meal at lunchtime on the night shift.
3. Exercising daily in the open air.
4. Reporting health disturbances to plant medical department.

Industrial plants operate on a one-shift, two-shift, or three-shift schedule. Each has various advantages and disadvantages. The single shift schedule usually begins between 7 and 8 A. M., which is not too early an hour for most women. There is danger that there will develop a tendency to work too much overtime. On the 48-hour a week basis women are forced to do all their shopping late in the day. Two-shift schedules are likely to start earlier in the morning with the consequent difficulty for married women on the first shift to complete their household tasks before leaving for work. Those on the second shift will stop work at a rather late hour in the evening. However, workers on both shifts will have ample daylight time for shopping. The danger, as with the single shift, is for long hours of overtime. On a three-shift plan there is little likelihood that a woman will work more than 8 hours per day. However, all the disadvantages of night work are greatly emphasized for those women on the third shift.

Although much has been written on the problem of the rotation of shifts, there is no uniformity of opinion on the time of the changes or the cycle of rotation. It would appear to be best for each woman to share the advantages of day work and the disadvantages of night work. Decisions as to the best periods for working on each shift should be based on practical experience. Investigations on this subject are summarized in the chapter on *Industrial Fatigue*. It has been stated by the Surgeon General of the U. S. Public Health Service that the change from day to night shift should not be more often than every 2 or 3 months. Women, in particular, have difficulty in adjusting to frequent

changes in shift. Young girls place great importance upon the opportunity for normal social life, while married women cannot easily change their entire home routine. Whatever the rotation cycle it is generally agreed that shift changes should always move forward and there should be an interval of at least one full day between shift changes. Work ending in the early morning or late evening brings special inconveniences to women employees.

Lunch and Rest Periods

Lunch periods vary in length from 15 minutes to one hour. In a certain group of plants one-fifth were found to allow less than half an hour. According to the U. S. Women's Bureau¹² a lunch period is too short if it does not give the worker time to leave the workroom, wash, and eat a well-balanced lunch and have a few minutes of leisure. If facilities are conveniently located 30 minutes should be sufficient. A longer time may be needed if lunch rooms are at a distance or workers are exposed to harmful substances which might contaminate their food unless washing is very thorough. Women who are unaccustomed to factory work especially need this noon break.

The need for *rest pauses* of five to ten minutes at the middle of the work spell is more widely recognized in England than in this country. It has been shown that such pauses actually increase output by 5 to 10 per cent, the more tiring and monotonous the work the greater the increase resulting from a rest. The length of the pause and when it is taken depends on the conditions in a particular plant. Ten minutes in the middle of each 4-hour spell is usually sufficient. Women who are sitting at work will need to rise and walk about to secure relaxation, while those who normally are standing will appreciate a chance to sit down.

Leaves of Absence and Vacations

The necessity of short vacations for persons working under emergency conditions is well established. Both women and men need these rest periods, which will break the monotony of their work, and in the long run result in improved productivity. Maternity leave, a question which will become more prominent as the number of married women employed increases, is treated in the following section. Another problem which has become important, is permission for wives to be absent when their hus-

bands come home on leave from the army. In other warring countries official provision has been made for this type of absence.

PHYSIOLOGICAL CONSIDERATIONS

Pregnancy

Among the problems which relate solely to women, pregnancy is one of the most important. Any plant employing women must give this subject serious consideration. As a general policy provision for maternity care and leave should not jeopardize the woman's job nor her seniority privileges. A statement¹³ has recently been prepared by the Children's Bureau and the Women's Bureau, both of the U. S. Department of Labor, in consultation with other interested persons on the subject of "Standards for Maternity Care and Employment of Mothers in Industry." It states that every woman should have opportunity for adequate prenatal care. She should have sufficient time off before delivery to allow her to be in a rested state at the time of delivery and to prevent undue strain in the latter part of pregnancy. Special consideration should be given if she is exposed to occupational hazards. Although it is recognized that hard and fast rules which will fit every situation cannot be formulated, the following general recommendations are set forth as a guide:

1. Facilities for adequate prenatal medical care should be readily available for all employed pregnant women; and arrangements should be made by those responsible for providing prenatal care, so that every woman would have access to such care. Local health departments should make available to industrial plants the services of prenatal clinics; and the personnel management or physicians and nurses within the plant should make available to employees information about the importance of such services and where they can be obtained.
2. Pregnant women should not be employed on a shift including the hours between 12 midnight and 6 A.M. Pregnant women should not be employed more than 8 hours a day nor more than 48 hours per week, and it is desirable that their hours of work be limited to not more than 40 hours per week.
3. Every woman, especially a pregnant woman, should have at least two 10-minute rest periods during her work shift, for which adequate facilities for resting and an opportunity for securing nourishing food should be provided.
4. It is not considered desirable for pregnant women to be employed in the following types of occupation, and they should, if possible, be transferred to lighter and more sedentary work.
 - (a) Occupations that involve heavy lifting or other heavy work.
 - (b) Occupations involving continuous standing and moving about.
5. Pregnant women should not be employed in the following types of

work during any period of pregnancy, but should be transferred to less hazardous types of work.

- (a) Occupations that require a good sense of bodily balance, such as work performed on scaffolds or stepladders and occupations in which the accident risk is characterized by accidents causing severe injury, such as operation of punch presses, power-driven woodworking machines, or other machines having a point-of-operation hazard.
- (b) Occupations involving exposure to toxic substances considered to be extra hazardous during pregnancy, such as: aniline, benzol (benzene) and toluol, carbon disulphide, carbon monoxide, chlorinated hydrocarbons, lead and its compounds, mercury and its compounds, nitrobenzol and other nitro compounds of benzol and its homologs, phosphorus, radioactive substances and X-rays, turpentine, and other toxic substances that exert an injurious effect upon the blood-forming organs, the liver, or the kidneys.

Because these substances may exert a harmful influence upon the course of pregnancy, may lead to its premature termination, or may injure the fetus, the maintenance of air concentrations within the so-called "maximum permissible limits" of State codes, is not, in itself, sufficient assurance of a safe working condition for the pregnant woman. Pregnant women should be transferred from workrooms in which any of these substances is used or produced in any significant quantity.

- 6. A minimum of 6 weeks' leave *before* delivery should be granted, on presentation of a medical certificate of the expected date of confinement.
- 7. At any time during pregnancy a woman should be granted a reasonable amount of additional leave on presentation of a certificate from the attending physician to the effect that complications of pregnancy have made continuing employment prejudicial to her health or to the health of the child.

After delivery it is desirable that the mother give her infant personal care for as long as possible. The following recommendations¹⁸ are made for those persons who must return to work:

- 1. All women should be granted an extension of at least 2 months' leave of absence after delivery.
- 2. Should complications of delivery or of the postpartum period develop, a woman should be granted a reasonable amount of additional leave beyond 2 months following delivery, on presentation of a certificate to this effect from the attending physician.

The details relating to the carrying out of the above recommendations are a responsibility of the company physician or the personal physician of the individual. His knowledge of the woman should determine what type of work she is able to do and when she should discontinue work entirely.

Laws relating to pregnancy are found in all industrial countries. In Russia because of war conditions maternity leave, which

had formerly been for 8 weeks before and 8 weeks after childbirth, was reduced to 5 weeks before and 4 weeks after.¹⁴ Germany¹⁵ has recently prohibited the employment of women for 6 weeks before and after childbirth. For nursing mothers the period is extended to 8 weeks. Overtime, night work, and holiday work are prohibited for pregnant women. However these laws do not apply to Jewish or "non-German" women.

In this country 6 States have legislation regulating the employment of women before and after childbirth. The time limits appear very short. For example, in Massachusetts and Vermont the period during which women shall not be required to work is 2 weeks before and 4 weeks after childbirth; in Connecticut it is 4 weeks before and 4 weeks after; in Missouri, 3 weeks before and 3 weeks after; in New York 4 weeks after; and in Washington, 4 months before and 6 weeks after.

Menstrual Periods

The industrial physician in a plant employing women will be called upon to give advice regarding menstrual complaints. Causal relation between a particular type of work and abnormal menstruation must not be too readily assumed. All the factors must be investigated as carefully as possible. It is generally considered that those women who have normal menstruations are not likely to endanger their health by performing their usual work during these periods, if the work they perform is safe during non-menstrual periods. As stated elsewhere it is important to have rest rooms equipped with cots. Women should be encouraged to use them, since it has been found that rest, local heat and simple medication soon return the majority to their work. Hot food and beverages are provided women during these periods by some plants.

The possibility that heavy lifting may cause menstrual difficulties might be investigated. A study made in Russia indicates that nearly twice as great a percentage of women doing strenuous work in heavy industries had menstrual troubles as compared with those working at lighter tasks.¹⁶

Physical Strength

There appears to be a substantial body of evidence that the strength of the average woman is less than that of the average man. The addition of women to the labor force necessitates increased attention to the problems of weight lifting and fatigue.

These problems assume more urgency in wartime when women are undertaking heavy work which in peacetime would not be considered appropriate for the female sex.

Legislation on the subject of weight lifting by women has been enacted in six States. According to the U. S. Women's Bureau present State regulation is inadequate and serves chiefly to show that a need for protection of women has been recognized in these states.¹⁷

The limit within which weights may be safely lifted is primarily an individual matter and no law can prescribe the load suitable for each woman. Thus a group of large companies employing many women has set a maximum weight varying from 15 to 50 pounds depending upon the tasks performed. Obviously even the 15-pound load might be too heavy for some women, while others could safely carry more than the 50-pound load.

Here is a field in which the industrial physician can be of particular service to the plant management. It is desirable that he approve the assignment of a woman to any job requiring lifting. To do this effectively he should be familiar with the *elements entering into weight lifting* and carrying. Individual human differences must be considered along with the characteristics of a particular job. The following are some of the items which the U. S. Women's Bureau considers important: the weight of units to be lifted; ratio of load to body weight; quantity lifted in a day; levels of lifting; compactness of load; distance and changes of level traversed in carrying load; interference of load with normal gait, respiration, or center of gravity; the degree of the turning of the body; the temperature and ventilation of the workplace; and the method of lifting.

Many of the difficulties connected with weight lifting can be overcome by the introduction of suitable *lifting and conveying devices*. Systems of moving goods which have been satisfactory so long as men were employed may require considerable changes in order that they may be better adapted to use by women. Where there is a continuous flow of material in one direction conveyor systems are applicable. The lift truck, hand or power operated, is a great energy saver and eliminates motions hazardous to hands, feet, and back. The stacker or tiering machine prevents strain on the abdominal muscles. A number of safe practices pamphlets issued by the National Safety Council may be of assistance in determining available types of mechanical aids.¹⁸⁻²¹

Much can also be accomplished by *reorganization of working*

practices without the addition of energy saving machines. For example, the work layout can be planned so that unnecessary lifting from one level to the other is avoided. A greater use of long work tables might be one solution. The distance materials must be carried from one operation to the other might be shortened.

Another important approach to the problem of weight lifting is that of instructing the worker herself on *approved methods of doing her assigned tasks*. Women should be informed as to the methods by which abdominal strain can be avoided; namely, keep the feet close to the object and use a narrow stance, the feet approximately 8 to 12 inches apart, bend the knees, keep shoulders back, use the leg muscles rather than the back. Approved methods for carrying loads should be taught. The U. S. Women's Bureau states that one of the most comfortable and economical methods is carriage on the shoulder. This leaves free the lower limbs and does not result in fixation of the chest. Tray carrying is said to be satisfactory only for short distances and irregular work. Continued transportation by this method may lead to undue fatigue and bad posture. Carrying bundles at the sides is suitable for short distances but it is likely to cause local fatigue of the hands and arms. Burdens on the hip interfere with normal walking and to some extent with natural breathing. It is undesirable for women to carry loads so that excessive pressure is placed on the chest or abdomen.

No set rules with regard to weight limitations can be given since the problem, in final analysis, resolves itself into putting *a particular woman into a particular job*. To do this successfully the plant physician must thoroughly understand the physical requirements for the job and must have made a complete medical examination of the worker. The latter should include a detailed history of past illnesses and operations. After the worker has begun her job attention should be paid to any changes which occur in her physical condition. Pregnancy, for example, frequently necessitates a change in type of work.

CLOTHING

With the entry of women into plants unaccustomed to employing female labor it is important for management to realize that in addition to protection against specific occupational hazards which they have long recognized new problems are presented. Whereas, ordinary work clothes may be satisfactory for

most men, the safety of women employees requires supervision over the kind of clothes they wear to work.

Types of equipment such as respirators, masks, goggles, and eye shields are discussed in Chapters 11 and 20 while protective clothing is considered in the chapter on *Occupational Dermatoses*. In this section desirable clothing standards applicable to women in general factory work are described.

According to the U. S. Women's Bureau⁵ clothing of all industrial workers should meet the following standards: (1) it must be reasonably comfortable in any temperature in which it is worn, (2) it must fit and not interfere with worker's movements, and (3) it must afford adequate protection against the particular hazards for which it is designed. It is more difficult for women to meet these standards than for men, since the ordinary daytime dresses of women are loose and flowing and the shoes they wear usually have high heels.

Both in this country and in England⁶ one of the difficulties encountered in recruiting women for war work is the fear that they will be forced to wear unbecoming clothes. When a campaign for safety clothing is initiated fashion appeal must be stressed. It should be made clear that women's clothes can be good looking as well as safe and that it is a patriotic duty to avoid accidents which slow production. There may be fewer complaints if, instead of requiring a uniform for all women, each is allowed to choose her own outfit provided it meets certain essential requirements such as low-heeled shoes, slacks, and short-sleeved shirts. *Applicants for employment should have a clear understanding of the type of clothing to be worn at work before they are hired.*

If a *uniform* is considered necessary because of safety or efficiency a women's advisory committee should be formed to decide the type or types of uniform, the style, material, and color. Variations are sometimes made by having the same style in different colors. In designing work clothes the following should be considered: Is there danger of the dress getting caught in moving machinery? Is the material resistant to fire? Will it last well? Will it be comfortable? Can it be laundered easily? Is there any possibility it will catch and hold dirt and dust? Is it as cool or warm as it needs to be for the job and season? Is it as attractive as possible?

Experience in many plants has shown that working women should avoid wearing loose sleeves, full skirts, jewelry, ties, or frills which are likely to catch on moving parts. All garments

should be close, but not tight fitting. Where there is any possibility of exposure to toxic materials clothing should be changed before leaving the plant. Generally it is laundered free of charge.

The U. S. Women's Bureau stresses the importance of wearing a *cap* when working around moving machinery.²² If the hair is long and no cap or net is worn electrical attraction may draw free hair into the machine with disastrous results. In designing a cap the aim should be to enclose all loose hair and at the same time avoid the possibility of the cap itself catching in the machinery. Sufficient height and stiffness of the cap are necessary. The head size should be loose enough to prevent headache and so that if the cap does touch machinery it will be thrown off. The employees should be consulted on matters of design, materials, and comfort. In dusty jobs a well-fitting cap or turban of closely woven, easily laundered material is suggested.

It is well known that *shoes* play a very important part in producing industrial accidents among women. Too often women workers are seen wearing sandals, bedroom slippers, or worn out shoes with thin soles and high or run-down heels. In addition to injury through falls complaints of fatigue and nervousness can sometimes be traced to badly fitting shoes. The plant physician should be on the alert for improper shoes among all of those who complain of pain in the feet or muscles of the leg. For comfort and safety low-heeled, closed-toe shoes should be insisted upon. Closed toes prevent injuries from stubbed toes and from the entrance of small particles of metal. Properly fitted shoes with good soles help maintain footing on wet or slippery floors. Special shoes may be needed in some occupations. If there is any danger of falling material, safety shoes should be worn. Wooden-soled shoes are necessary where workers are subject to acids, moisture, or great heat. Women in munitions plants must wear shoes with sewed or wooden-pegged soles, and heels with copper nails.

Work gloves are even more important for women than for men, since the former are more likely to be concerned over any slight disfigurement of their hands. As is the case with all protective clothing, gloves must be carefully chosen for the particular task they are intended to aid. They must be comfortable and durable as well as protective. Women do much assembly work which requires the handling of sharp or rough objects. Gloves or finger guards are suggested in place of the adhesive tape often seen around workers' fingers. Where hands are exposed to toxic

materials proper protection is essential. Around moving machinery gloves are prohibited. Substitute protection is available through creams or varnishes, which are described in detail in the chapter on *Occupational Dermatoses*.

Jewelry and ornaments which women normally wear such as rings, bracelets, watches, necklaces, earrings and dress ornaments, are likely to be hazardous for industrial workers. Some companies make definite rules that no visible jewelry be worn.

Additional information concerning appropriate dress for women engaged in certain kinds of labor may be secured from the Women's Bureau, and the Bureau of Home Economics of the Department of Agriculture.

ABSENTEEISM

Under the term *absenteeism* is included all failure to appear at work whether attributed to personal sickness, industrial or nonindustrial injuries, occupational diseases, or personal reasons.

Personal Sickness

Studies of personal sickness show that women are sick more often than men. This excess is most noticeable among workers in the younger age groups, and among persons with absences lasting one or two days. The socio-economic status of women may be a factor but it cannot be of much importance since the excess for women remains when males and females in the same occupations are compared.

Reports from a group of industrial sick benefit organizations concerning disabilities lasting 8 consecutive calendar days or longer show that during a five-year period the frequency rate of sickness (average number of sick absences per 1,000 workers) was 68 per cent greater among females.²³

Experiences of a company including all sick absences lasting 1 day or longer showed an excess in the rate for females of 114 per cent. In a study of mail order store employees the frequency of sickness among married and single women was not significantly different when females in the same age group and occupation were compared.²⁴

Women are usually absent for a shorter time per illness than are men, especially when 1 day or longer cases are considered. For 8-day or longer cases there is little difference in the average length of case between males and females.

In one company it was found that approximately half of the

male employees and three-fourths of the female employees were absent because of sickness one or more times during a year. Two and one-half per cent of the males and twelve per cent of the females were absent four or more times. This excess of multiple attacks among females suggests an important subject for investigation by the plant medical department. Attention might profitably be directed toward the relatively small group of females that is responsible for a disproportionate number of the total absences.

Industrial Injuries

There are insufficient data to determine whether industrial injuries as a cause for absence differ greatly in either frequency or severity between men and women. However, there is some evidence that, classed by the type of injury, women have more falls than men. This may be related to the footwear of women and suggests that especial care should be devoted to the selection of proper shoes. Women are said to be more apprehensive of accidental injury with its threat to looks than are men. To allay this fear one company reports that it has agreed to employ a plastic surgeon for any girl operator who might need his services. Safety programs generally do not make any distinction between women and men. Women who lack mechanical familiarity and experience require very careful training in the safe operation of machines. Once they have learned the proper methods they may prove safer operators than men because they do not have bad habits to unlearn.

Nonindustrial Injuries

Nonindustrial injuries causing disability lasting 8 calendar days or longer per 1,000 persons were 9.8 for males and 12.5 for females for 11 companies during a 13-year period.²⁵ Each year showed a slight excess for nonindustrial injuries among females. The difference between male and female rates was largely due to a relative excess among females of injuries to the lower extremities and injuries to multiple parts of the body. When a company which reported disabilities lasting from 1 to 7 days, inclusive, was selected the relative excess of female cases became considerably greater.

Occupational Diseases

Occupational diseases in most plants represent only a very small fraction of the total time lost from work. The greater sus-

ceptibility of women to certain toxic materials has been frequently asserted. Whether or not there are genuine sex differences is not of so great importance to plant management as is the necessity for engineering and medical study, and control which will preclude the possibility of poisoning for any worker.

Personal Reasons

Absences because of personal reasons are frequently difficult to separate from illnesses. There is always a temptation for workers to report any absence as due to sickness. Certain reasons for absence are likely to have greater force with women than with men. For example, domestic responsibilities are often a problem with married women who attempt to keep a home running smoothly and to work full time. When a child is sick or if household tasks are not completed they naturally have a strong desire to take some time off. Unmarried women often must care for parents or other relatives. Opportunities for shopping are limited for working women. This is becoming a more serious problem as additional restrictions on the distribution of goods are imposed. Women workers complain that unrationed foods have all been sold before they have a chance to shop.

For some women the economic motive for working is weakened because other members of their family earn sufficient to provide living expenses. As taxes increase and articles become scarce there will be fewer opportunities to spend any money which has been earned. The patriotic motive will need to be stressed; women who are convinced they are contributing to the war effort will not wish to take time off except for genuine emergencies. Hours of work adjusted to women's needs and better transportation have been found to reduce absenteeism for personal reasons.

COMMUNITY RELATIONSHIPS

The lives of all workers and especially women workers cannot be segregated into *on the job* and *off the job*. Any one interested in maintaining women's health and welfare must of necessity consider their whole life and how the one part reacts with the other. War workers more than other women workers are likely to consider the off-the-job aspect of their lives of greater importance because they realize that when the emergency is over they are likely to drop out of the labor market entirely. Much of the reluctance to hiring married women workers is said to be

due to the fear of possible interruptions of their work schedule because of urgent domestic problems. Unmarried women cannot be employed in great numbers unless they live in the immediate vicinity of the plant, or suitable housing can be provided for them.

Transportation

Transportation presents a more serious problem for women than for men, especially those on the second or third shift. Women arriving or departing in the early morning or late evening hours are frequently fearful about walking any distance to public transportation. Most companies make an effort to have the streets, bus stops, and railroad stations near the plant carefully patrolled when shifts are changing. This, however, does not protect the women when they leave the cars. Infrequent transportation schedules between midnight and 6 A. M. increase the difficulties for the employment of women. Possible remedies for this situation are local dormitories, concentrated hiring from certain areas with provision for special bus service to those sections, and refusal to employ individuals from outlying areas who would have difficulty in night transportation. When several persons from the same neighborhood ride to and from work together, the arrangements may be complicated by the practice of men working more overtime than women. Transportation facilities must be considered by any plant planning to hire a large number of women. Shift hours may have to be rescheduled to meet these facilities.

Housing and Recreation

In the early part of the war program workers moving into industrial areas have usually been men and their families. As the shortage of labor increases, single and non-family women will enter industry in larger numbers. This will change the kind of housing required from family type dwellings to single rooms in private homes or dormitories. Industry cannot avoid some concern with housing, since the morale, health and productivity of its women workers are related to adequate housing.

Recreation and housing are closely linked. At a time when large numbers of girls and young women have been drawn from their normal home environment into areas of suddenly congested population their need is both for healthful low cost living facilities and for wholesome leisure time pursuits. Requirements for

housing and recreation differ according to the type of industrial area. The following main classes of industrial area are listed by the U. S. Women's Bureau:²⁶

1. Large cities, which have many facilities, diversified but inadequate because of the expanded population.
2. Smaller cities and towns where existing facilities were or still are few, undiversified, and wholly inadequate for a suddenly increased population.
3. Sparsely settled and hitherto undeveloped areas converted within a few months into manufacturing centers, into which large numbers of industrial workers and service employees have been brought but which are totally devoid not only of facilities for normal living but of essential businesses and trades.
4. The suddenly expanded or newly developed environs of military camps and forts, which have inadequate facilities to meet not only certain needs of the men in the service but the varied needs of large numbers of workers, particularly women, brought into the area by the mushroom growth of service industries.

Programs to meet the needs of these areas are suggested in the bulletin referred to above.²⁶ Among the more important matters considered are a local room registration service which will prevent hit-or-miss room finding, adequate standards for the construction of low-cost dormitories, a recreational program to meet the need of women on rotating shifts, personnel for directing recreational activities, equipment for a recreation center, and a list of agencies interested in recreation.

Care of Children of Working Mothers

As the labor market becomes tighter it may be necessary in certain areas to employ women who have young children. Among married women those of an age most desired by industry are likely also to have children of preschool or early school age. It is agreed that mothers of preschool children and especially of those under 2 years of age should not be encouraged to seek employment. Children of these ages should in general be cared for by their mothers in their homes.

A Conference on Day Care of Children of Working Mothers, held July 31 and August, 1, 1941, included, among others, the following recommendations:²⁷ it is a public responsibility to provide appropriate care of children while mothers are at work; advance information concerning plans for increased employment of women should be made available to community agencies; working mothers who cannot make arrangements for adequate care of their children by relatives or friends should be provided care

by the community; nursery schools, nursing centers, and cooperative nursery groups should be developed as community services, under the auspices of public or parochial schools, welfare departments, or other community agencies; and finally, these services should not be located in industrial plants or limited to children of mothers employed in particular establishments. Other U. S. Children's Bureau publications give a detailed account of methods for the practical application of these principles.²⁸⁻³¹

A release dated December 10, 1942, from the U. S. Children's Bureau states:

On August 28, 1942, the President allotted to the Office of Defense Health and Welfare Services \$400,000 for the promotion and coordination of programs for the care of children of working mothers. These funds were to be expended through grants to States by the Office of Defense Health and Welfare Services on the basis of State plans recommended by the Children's Bureau or the U. S. Office of Education. The U. S. Office of Education has responsibility for giving consultation services and for reviewing plans submitted by the State departments of education; and the Children's Bureau has responsibility for giving consultation services and for reviewing plans submitted by the State departments of welfare.

CONCLUSION

The proportion of women in all types of employment is increasing and is certain to continue to increase as the war continues. Any influx of new workers creates industrial hygiene problems. The basic essentials for maintaining a healthful working environment are the same for both sexes. However, the addition of women does bring a different emphasis in certain respects. These differences are probably due as much or more to the social environment in which females are surrounded from birth as to differences in physical constitution. Many times dogmatic statements concerning work unsuited for women have been found to have no foundation in fact. Women have demonstrated their ability to work without injury to health in many new fields of endeavor. An individualized approach is necessary, regarding each woman worker in the light of her physical constitution and the particular job to which she is assigned. Medical control beginning with her placement and following through her entire working experience is the only assurance that her health will not be adversely affected.

A company hiring many women should consider, among other things, the following: possible changes in plant facilities, including reengineering of jobs, seating, toilets and rest rooms, medical

facilities, mechanical methods for moving goods, and eating facilities; the arrangement of hours of work, lunch periods and shift rotation best suited to women; policies with respect to pregnancy; regulations concerning work clothing; methods for controlling absenteeism; and community provisions for transportation, housing, recreation and child care.

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CHAPTER 24

ABSENTEEISM

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THE entrance of the United States into active warfare has made extraordinary demands on the productive capacities of industry. These demands are being reflected in certain factors which, according to past experiences, will probably increase the magnitude of the problem of industrial absenteeism whether accounted for by sickness or by personal reasons. Among these factors may be mentioned, the increased employment of youth, the older worker, and of women; the hiring of workers long unemployed, of the inexperienced, and of many persons excluded from the armed forces for some reason or another; green authority; overcrowding in the plant; the migration of workers particularly from the country to the city; and the associated multitudinous changes in the working, home, and community conditions. It is the purpose of this chapter to assist in the solving of a problem which is seriously affecting industrial production.

SICKNESS

It is unnecessary at this time to refer further to the existence of the problem of sickness among industrial workers nor to its importance. References to the extraordinary excess of days lost from sickness when compared with those lost from occupational diseases and injuries have repeatedly appeared in the literature. Moreover the number of days lost annually from sickness has been frequently converted into a sizable number of tanks, guns, planes, and ships. In short the problem of immediate concern is one of *prevention* and *control*. The industrial physician, therefore, finds himself confronted with the responsibility of determining where, when, and under what conditions ill health is occurring. Thus there is required a measure of sickness for the purpose of making various comparisons within and among different companies for a particular year, or for a selected period of time.

SICKNESS ABSENTEEISM RATES

To take into account all departures from physical or mental health regardless of severity would be a colossal and, at present, an impracticable task since there would be included minor ailments or defects causing discomfort and inefficiency, as well as physical and mental impairments, any of which would not seriously interfere with working capacity. At present, absenteeism from work on account of sickness is the generally accepted measure. *Mortality* on the other hand as a sole index of departure from health has long been discarded since it has been shown on several occasions that the pictures resulting from the simultaneous application of a rate of mortality and a rate of sickness to a given population are by no means identical. In other words there are causes of invalidism and incapacity which can hardly affect a death rate.

The decision to adopt *time lost* as a measure of departure from health has, as was pointed out, automatically rejected minor ailments or defects and certain physical and mental impairments with none of which is there associated a loss of time. Thus the level of sickness absenteeism is measured, though not necessarily the level of sickness.

Two rates involving time lost have been constructed. These are commonly known as the *disability rate*, and the *severity rate*. The disability rate is the average number of days lost per year per worker, while the severity rate is the average number of days lost per absence. A third rate of considerable importance is the *frequency rate* or average annual number of absences per 1,000 workers. For *preventive* purposes the frequency rate is a most useful one. Rates involving time while convenient for determining economic losses disclose nothing, for example, about the number of sources of infection. Thus the records might show three colds per year disabling on the average for five days each; another set of records might show one cold disabling for fifteen days. The three short colds present perhaps more of a problem to the plant and the community than the long one because of the possible effects from greater likelihood of spread of infection. In this hypothetical situation rates involving time would take into account only the days disabled, fifteen in each instance, and, consequently, would not differentiate the three-cold and one-cold experiences.

It is helpful to remember that the three rates referred to are related and that because of this relationship any one of the

three may be obtained from the other two. For example, the disability rate equals the product of the frequency and severity rates divided by 1,000.

COMPARABILITY OF RATES

Causes of Differences

Let it be assumed that two plants have calculated a sickness absenteeism rate. If one rate is significantly larger than the other can it be concluded that the forces responsible for disabling sickness are greater in number or intensity in one plant than in the other? A sound conclusion can be formed only if information concerning a number of factors is available. Thus the difference in rate may be primarily accounted for by the presence of a larger proportion of older workers in one plant than in the other, or by a larger proportion of women. For example with regard to age, a plant may yield a sickness absenteeism rate significantly different from the rate found for another plant but when the rates are made specific for age the corresponding rates may be very much alike. Thus the force of morbidity may be of the same magnitude in the two plants but because of differences in the two age distributions of the workers the rates for all ages combined may show a significant difference.

There is a host of other factors of importance in the matter of the comparability of rates particularly those influencing absenteeism data yielded by the records of industrial sick benefit organizations. Among such factors may be listed the following (compare reference 1) :

1. Whether membership in the sick benefit organization is compulsory or voluntary.
2. Age limits for membership.
3. Whether or not membership depends upon a certain length of employment.
4. Whether or not certain occupations debar from membership.
5. Whether or not chronic diseases debar from membership.
6. The resources of the benefit organization.
7. Effectiveness of claim supervision.
8. Methods of administration of sick benefits.
9. The average wage of the insured, and the per cent of wages paid in sick benefits.
10. Personal equation of the sick worker.
11. The waiting period. A waiting period at the beginning of disability, usually seven days, stipulates that cases of less than a certain length may not be certified for benefits. Hence such cases are not in the records.
12. Retroactive payment of benefit for the waiting period if the illness produces incapacity of more than a specified period.
13. The period of maximum benefit. Cases of disability are usually closed after a certain number of weeks has elapsed.

Frequency of Factors Affecting Rates

It is of interest to review the relative frequency of occurrence of some of the factors possibly affecting the comparability of rates yielded by the records of industrial sick benefit organizations. There are available the results of a survey² of the sick benefit organizations, primarily mutual sick benefit associations and group insurance plans, connected with approximately 700 plants representing over a half-million workers. In 70 per cent of the plants membership in the sick benefit organization was voluntary. In 60 per cent there were no age limits for membership; in those plants with age limits, the lower limit varied from fourteen to twenty-one years while the upper limit varied from thirty-five to seventy years.

Some plants subscribed to certain service requirements. Thus 25 per cent of the plants admitted the employee to membership immediately upon application; the remainder required varying periods of employment before eligibility for membership. A number of plants required a full year's employment.

With regard to the exclusion of employees in certain occupations, 80 per cent of the plants admitted to membership employees in all occupations.

About 30 per cent of all plants either debarred from membership those employees with chronic diseases or admitted such employees to membership with the understanding that no benefits will be paid for those diseases. In some instances an employee's exclusion from membership is left to the discretion of the company or organization.

Of importance also in this connection are the practices with regard to the *notification*, *certification*, and *verification* of disability. To draw benefits a disabled member must report his condition to the sick benefit organization. The rule regarding the length of the time interval between onset of disability and its subsequent reporting varied; some plants required a report within twenty-four hours, others within forty-eight hours, and still others stipulated two or more weeks. Practically all plants required an examination by a physician and also that a certificate be submitted to them. Methods for the control of "malingering" were reported by nearly all of the plants; these methods included the services of a visiting committee, a physician or a nurse designated to call upon the disabled member.

Reference has been made to the effect on the sickness absenteeism rates of the waiting and maximum benefit periods. Approximately 1 per cent of the plants had no waiting period

after onset of disability, 60 per cent had a seven-day waiting period and 10 per cent had a seven-day waiting period with payments of benefits retroactive to a specified date. The benefit period per case of disability ranged from three to 104 weeks. Twenty-five per cent of the plants paid benefits for thirteen weeks with a limit of six weeks for cases of pregnancy while 15 per cent paid for twenty-six weeks.

It is obvious from the foregoing that a number of factors, both natural and artificial, must be considered before any conclusions are drawn from the rates.

Conclusions

The difficulties connected with the drawing of sound conclusions from sickness absenteeism data have perhaps been sufficiently emphasized. Attention, however, should also be directed to the matter of *cause* and the *onset of illness*, both of which may be frequently outside of employment and unrelated to it. Moreover, the diagnosis may be at times equally uncertain.

Because of the importance of the problem of sickness among industrial workers, the difficulties surrounding its investigation should not discourage the collection of data and any attempts that might be made in their analysis. The pertinent data therefore should be uniformly recorded, carefully analyzed, and interpreted with caution.

DISABLING SICKNESS RELATED TO VARIOUS FACTORS AND INDEXES

Distribution of Sickness

The sicknesses experienced by a group of industrial workers during a particular period of time are not uniformly distributed among the workers. This indicates, among other things, the existence of the "repeater" knowledge of whom is essential in any program for the reduction of absenteeism. Thus in 1939 among a group of approximately 3,000 male workers, 44.8 per cent of the workers had no disabling sicknesses of one day or more recorded for them, 31.5 per cent had one sickness each, 13.0 per cent had two sicknesses, 6.7 per cent had three, 2.5 per cent had four, 0.9 per cent had five, 0.4 per cent had six, 0.1 per cent had seven, and 0.1 per cent had eight.³ Figure 5 presents the percentages graphically.

Another group measured during the six years, 1935-40, revealed that approximately one-half of the male workers and

one-fourth of the female workers were not disabled on account of sickness at any time during a year for as long as one day or more.⁴ Sixty-five per cent of the male disabilities occurred among workers representing only 21 per cent of those exposed to risk of disability. For the females 63 per cent of the disabilities occurred among 27 per cent of the female workers. In general, increasing age tends to reduce the number of disabilities which one worker may suffer during a particular year, but the average

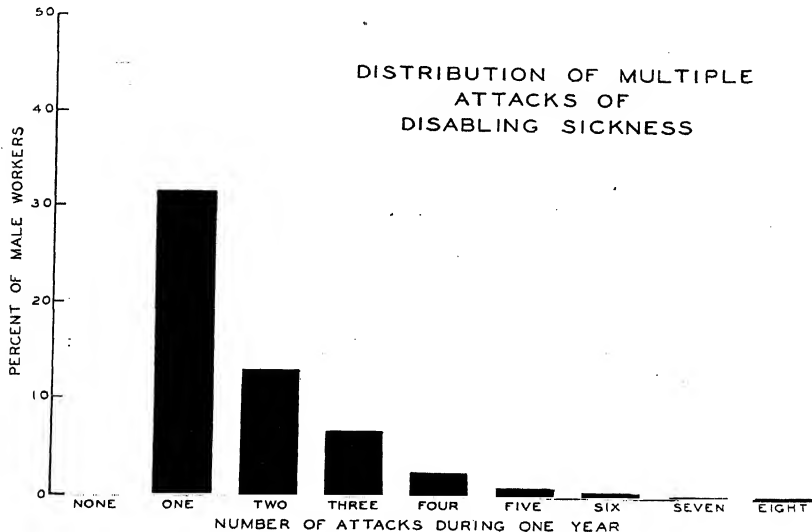


Fig. 5.—Distribution of the occurrence of multiple attacks of disabling sickness; experience of 3,000 male workers in a public utility, one calendar day or longer absences, 1939.

length of each disability tends to increase. Thus, 4.1 per cent of all males under thirty years of age were disabled four or more times during a year while 2.5 per cent of all males fifty years of age and over were disabled the same number of times. The corresponding percentages for the females are 20.6 and 6.0, respectively. Workers with four or more disabling sicknesses during one year, were disabled several times the following year.

Figure 6 shows graphically the relationship between any selected percentage of workers and the corresponding percentage

of absences recorded for them; in addition there is shown the percentage of all days absent for a given percentage of workers. The absences lasted one day or longer and were caused by sickness or injuries, and the experience represents approximately 1,000 male workers of the sales force of an industry for the year

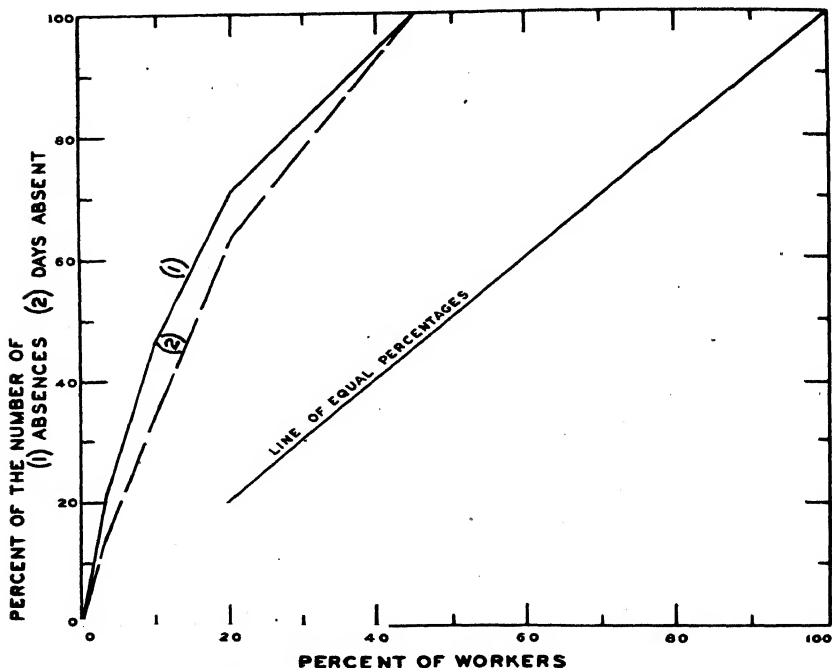


Fig. 6.—Percentage of the number of absences and percentage of all days absent corresponding, respectively, to different percentages of workers; experience of 1,000 males comprising the sales force of an industry, one calendar day or longer absences accounted for by sickness and injury, 1940.

1940.⁴ An examination of Fig. 6 reveals, among other things, that 45 per cent of the workers were responsible for all the absences, and hence all of the days absent; moreover, 10 per cent of the workers accounted for almost 50 per cent of the absences and over 35 per cent of the days absent. If all workers had been absent and each had been absent the same number of times dur-

TABLE 1.—FREQUENCY OF ABSENCES LASTING ONE DAY OR LONGER DUE TO SICKNESS AND INJURIES, ANNUAL NUMBER OF DAYS OF DISABILITY PER PERSON, AND AVERAGE NUMBER OF DAYS PER ABSENCE, BY CAUSE; EXPERIENCE IN A PUBLIC UTILITY, 1938-1941, INC.*

Cause (Numbers in Parentheses are Disease Title Numbers from the International List of Causes of Death, 1939)	Annual Number of Absences per 1,000 Persons		Annual Number of Days per Person		Average Number of Days per Absence		Number of Absences Ending During 1938-41		Number of Days of Disability	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
<i>All disabilities</i>	919.7	1,851.2	8.324	11.911	8.95	6.43	10,049	4,554	89,966	29,300
<i>Industrial injuries</i> (160-195).....	22.4	4.5	0.078	0.039	30.23	8.73	245	11	7,406	96
<i>Intoxicated injuries</i> (169-195).....	42.8	80.9	0.464	1.211	10.85	14.97	468	199	2,970	5,070
<i>Sickness</i>	594.5	1,765.8	7.092	10.661	8.30	6.04	9,336	4,344	77,484	26,225
<i>Respiratory diseases</i>	541.7	947.1	2.938	4.520	5.43	4.77	5,019	2,630	32,082	11,119
Influenza, grippe (33).....	148.6	169.5	1.044	1.096	6.93	6.47	1,624	1,411	10,718	3,716
Colds and coryza (104).....	252.1	455.3	0.708	1.274	2.81	2.80	2,754	1,120	7,798	3,133
Bronchitis, acute and chronic (106).....	53.6	82.5	0.368	0.539	6.35	6.54	556	208	4,016	1,327
Pneumonia, all forms (107-109).....	3.7	3.2	0.176	0.153	48.05	47.00	40	40	1,921	376
Diseases of pharynx and tonsils (110, 116).....	62.3	180.1	0.394	1.002	5.37	5.57	680	443	3,649	2,466
Whooping cough (111).....	1.0	0.8	0.163	0.100	102.36	123.60	11	2	1,796	245
Other respiratory diseases (104, 105, 110-114).....	20.5	55.1	0.173	0.356	8.43	6.39	224	137	1,888	875
<i>Dyspeptic diseases</i>	153.7	324.4	1.133	1.513	7.69	4.66	1,679	798	12,912	3,729
Diseases of teeth and gums (115a, 115d).....	17.0	37.5	0.050	0.126	2.91	3.32	186	93	641	309
Diseases of stomach, cancer excepted (117, 118).....	82.6	178.0	0.335	0.834	5.27	2.16	903	438	4,758	944
Dyspepsia (120).....	34.0	72.6	0.133	0.234	3.90	3.18	371	131	1,447	570
Other digestive diseases (116, 122-123).....	11.3	15.3	0.234	0.534	32.97	34.58	94	38	3,099	1,314
<i>Non-respiratory-non-dyspeptic diseases</i>	135.1	364.6	2.857	3.639	21.31	10.80	1,476	897	21,219	9,600
Infectious and parasitic diseases.....	9.1	7.3	0.166	0.071	18.31	9.67	99	15	1,813	174
Rheumatism, acute and chronic (83, 59).....	5.1	6.5	0.207	0.448	40.39	65.88	56	10	2,202	1,102
Diseases of organs of movement except joint (156b).....	32.8	58.5	0.275	0.272	8.39	4.65	388	144	3,002	669
Dysentery (84).....	1.0	0.5	0.023	0.111	13.82	7.41	120	37	1,658	274
Neuritis and the like (Part of 84d).....	1.0	1.0	0.024	0.129	64.99	48.29	126	72	991	697
Other diseases of nervous system (60-85, 87, except part of 84d, and 87b).....	4.2	11.3	0.174	0.199	64.99	48.29	126	72	991	697
Diseases of organs of vision (83).....	7.6	10.6	0.037	0.074	11.47	6.80	86	28	2,689	473
Diseases of ear and mastoid process (88).....	4.6	10.1	0.033	0.064	7.18	8.24	50	23	359	306
Diseases of heart and arteries (90-93).....	6.3	5.3	0.306	0.280	80.43	52.92	69	13	5,550	688
Other diseases of circulatory system (100-103).....	12.8	17.9	0.281	0.294	21.97	16.45	140	44	3,076	724
Diseases of genitourinary system (130-138, part of 139).....	11.2	23.6	0.355	0.491	31.58	20.84	123	58	3,884	1,209
Diseases of the skin (141-143).....	12.4	24.9	0.150	0.294	11.25	2.38	146	53	1,643	591
Diseases of the joints (145).....	4.7	8.0	0.069	0.148	12.82	30.33	51	14	364	364
All other diseases (45-57, 60-70, 140-150, 154, 155, 157, 162).....	7.3	18.7	0.213	0.700	29.74	37.41	80	46	2,379	1,721
<i>Ill-defined and Unknown Causes</i> (200).....	24.0	129.7	0.117	0.639	4.83	5.31	202	319	1,278	1,604

* The number of days of disability is the number of calendar days from the date disability began to the date of return to work, or to the 372nd day inclusive. Number of person-years of exposure, males 10,926; females 2,460.

ing the year, any chosen percentage of workers would be responsible for an equal percentage of absences, and the relationship between the two variables would be expressible graphically by the line of equal percentages shown in Fig. 6. Moreover if each of the workers had been absent the same number of times and if all of the absences had been of the same duration, or if all of the workers had been absent during the year an equal number of days, the line of equal percentages would also express the relationship between workers and days absent.

The Causes of Sickness

Frequency, disability and severity rates based on a four-year experience of a public utility, 1938-41, are shown by sex and cause in Table 1.⁴ Attention is directed to the excesses in the frequency and disability rates shown by the females when compared with the males, the severity rates being generally higher for the males.

It will be observed, also that the respiratory group of diseases is responsible for over half of the absences and over one-third of the days absent. In the respiratory group colds exact the largest toll of absences. While the number of absences is relatively low for the nonrespiratory-nondigestive group of diseases the corresponding days absent are of a magnitude similar to the days accounted for by the respiratory group, the principal time-loser being the rheumatic group of diseases (rheumatism, acute and chronic; diseases of organs of movement except diseases of joints; and neuralgia, neuritis, and sciatica). The absences for the digestive group and the nonrespiratory-nondigestive group of diseases are similar in number, the outstanding cause under the digestive group being diseases of the stomach, cancer excepted.

Average Daily Percentage of Workers Disabled

This is an extremely useful index of disability. In a study of the 5-year record of sickness and nonindustrial injuries disabling for 8 calendar days or longer among a group of 60,000 railroad workers it was found, among other things, that the average daily percentage of workers disabled was 3.7 per cent.⁵ This percentage varied according to age group from 1.2 at ages less than 25 years to 10.7 at ages 65 years and over. The following table gives the percentages by age group and the data from which they were calculated. It will be observed that the per-

centages increase with age group in an orderly manner. A semi-logarithmic graphical representation of the percentages against age group shows the increasing trend to be expressible approximately by a straight line indicating that the percentages increase at an approximately uniform rate.

Age Group in Years	(1) Total Days of Disability	(2) Number of Person- Years of Disability	(3) Number of Person- Years of Exposure	(4) Average Daily Per- centage of Workers Disabled (2) ÷ (3)	(5) Annual Number of Days of Disability per Worker (1) ÷ (3)
All ages.....	3,339,814	9,150	246,383	3.7	13.6
Less than 25.....	29,484	81	6,910	1.2	4.3
25-34.....	341,505	936	49,163	1.9	6.9
35-44.....	752,599	2,062	77,094	2.7	9.8
45-54.....	1,014,148	2,778	71,364	3.9	14.2
55-64.....	1,033,620	2,832	37,084	7.6	27.9
65 and over.....	163,222	447	4,171	10.7	39.1
Unknown.....	5,236	14	597	2.4	8.8

The table also gives the corresponding annual number of days of disability per worker. This rate increased in an orderly manner from 4.3 days at ages less than 25 years to 39.1 days at ages 65 years and over; at all ages the rate was 13.6.

Epidemics

It is of interest to examine the effect of a respiratory disease epidemic on a morbidity index, for example, the average daily percentage of workers disabled. The requisite data are made available by the record of one day absences or longer that occurred among the male workers of a public utility company.⁴ For the first five weeks of 1940 the average daily percentage of workers disabled varied from week to week as follows: 2.6, 2.7, 2.9, 2.6, and 2.6; the corresponding percentages for the year 1941 were found to be 4.1, 6.8, 7.3, 5.1, and 3.7, respectively. The excesses in percentage are primarily attributable to the respiratory disease epidemic prevalent at the time.

Season

The seasonal variation of sickness from certain causes is well known. The following observations are based on eight-day or longer disabilities.

For the respiratory group of diseases the first quarter of the year generally shows the highest frequency rate when compared with the rates for the other quarters. In fact this rate is frequently found to be from twice to three times the rate for the third quarter of the year; in the epidemic year of 1937 the first quarter rate was over four times the corresponding rate for the third quarter.⁶

Seasonality was also shown by diseases of the skin, the third quarter frequency rates appearing as peaks in a graph covering all quarters of the ten-year period, 1930-39.⁷ A notable seasonal variation was also exhibited by diarrhea and enteritis for the ten-year period, 1932-41, the third quarter rates consistently showing a peak.⁸

Time

Inquiry into the matter of time-changes in rates of sickness frequently leads to fruitful conclusions particularly with reference to the question of the effectiveness of, or the necessity for, specific control measures. The results of a recent study covering an eighteen-year sickness experience are of interest.⁹ This study dealing with the time-changes in the frequency of sickness and nonindustrial injuries causing disability lasting more than one week disclosed the following:

1. All sickness showed a downward trend which was more in evidence among males than among females, the principal determining factor of movement being the respiratory diseases.
2. Nonindustrial injuries showed an upward trend among females as well as males.
3. The trends of the female-to-male ratio rose, those representing the respiratory and nonrespiratory groups almost at the same rate while the nonindustrial injury trend rose more slowly.
4. Among males, diseases of the circulatory system, including diseases of the heart, and appendicitis, showed an upward trend.
5. While not precisely the same, the trends among males were downward for the three industrial groups, iron and steel, public utilities, and miscellaneous industries, in respect of all sickness, respiratory diseases, pneumonia, and respiratory tuberculosis, and upward for diseases of the circulatory system including diseases of the heart.

Epidemics and Season

Of considerable interest is a graphical presentation of the elements of epidemicity and season as yielded by one large experience. Data on this experience have appeared quarterly in the *Public Health Reports* (an index of the publications through the fourth quarter of 1940 has appeared¹⁰). Over 125,000 male work-

ers are involved and the frequency rates are based on disabilities causing absences of eight calendar days or longer.

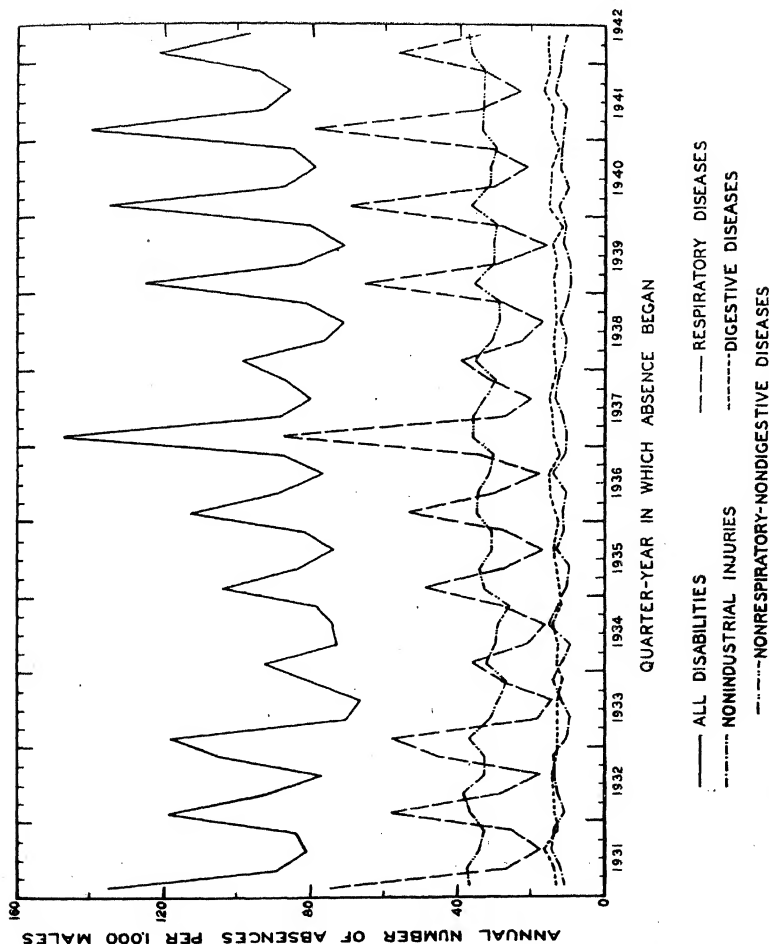


Fig. 7.—Average annual number of absences per 1,000 males from sickness and nonindustrial injuries disabling for eight calendar days or longer, according to broad cause groups, by quarter-year in which absence began; experience of male employees in various industries, 1931-42, inclusive.

Figure 7 shows the material graphically. It will be observed that the quarterly frequency rates for four broad cause groups,

and all disabilities cover the time period beginning with the first quarter of 1931 and ending with the second quarter of 1942. Attention is directed to the seasonal variation of the respiratory diseases and the reflection of this variation in the graph for all disabilities. While the seasonal variation of the nonrespiratory-nondigestive diseases is recognizable it is much less pronounced, maximum frequencies occurring in the first or second quarters. Epidemics of the respiratory diseases are in evidence. Reference is made particularly to the epidemics of the first quarter of 1931, 1937, and 1941 respectively; of interest are the increasing peaks prior to 1937 and 1941.

During the entire time period the quarterly frequencies for the digestive diseases varied between 11.5 (4th quarter, 1933) and 16.5 (3rd quarter, 1941) while the nonindustrial injuries varied between 9.2 (2nd quarter, 1933) and 15.0 (3rd quarter, 1934). These cause groups present no striking periodicity but show a tendency to yield a maximum frequency in the third quarter.

The quarterly rates for a number of selected years from the group 1931-42 have been superimposed as presented graphically in Fig. 8 in order to show the range of variation of the quarterly rates for particular quarters. Noteworthy is the range of the first quarter rates for the respiratory diseases from 36.2 in 1934 to 87.5 in 1937.

The epidemicity shown by Fig. 7 emphasizes the necessity for selecting a control group of workers when testing the effectiveness of a particular measure of prevention or control. Thus a comparison of the frequency of respiratory affections after feeding a group of workers, say, vitamins, during a non-epidemic year with the corresponding frequency yielded by the same group of workers during the previous epidemic year contributes very little to the knowledge of the value of the feeding of vitamins.

Time Changes in Quarterly Frequencies

The question frequently arises of the behavior of the frequency of disabling sickness for a particular quarter-year in relation to the passage of time. Figure 9 presents graphically the pertinent data covering the ten years, 1933-42.⁴ It will be observed that the trend of the frequency of eight-day or longer sicknesses for each quarter moves upward, and that the rates for the first quarter show the greatest variability and are consistently highest; the rates for the third quarter are consistently

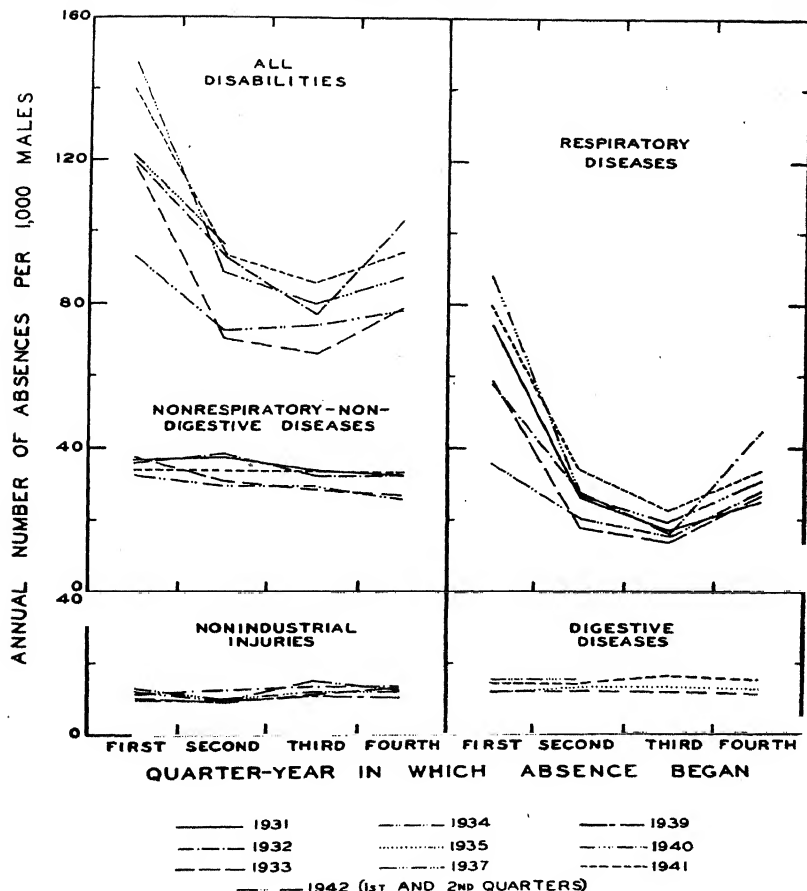


Fig. 8.—Average annual number of absences per 1,000 males from sickness and nonindustrial injuries disabling for eight calendar days or longer, by quarter-year in which absence began, certain selected years for each broad cause group superimposed; experience of male employees in various industries, 1931-42, inclusive (compare Fig. 7).

lowest while those for the second and fourth quarters are more or less similar. The rates of increase of the frequency for each quarter, apparently, are not conspicuously different.

Occupation

Some occupations appear to be more associated with ce disabling sicknesses than other occupations. According to a

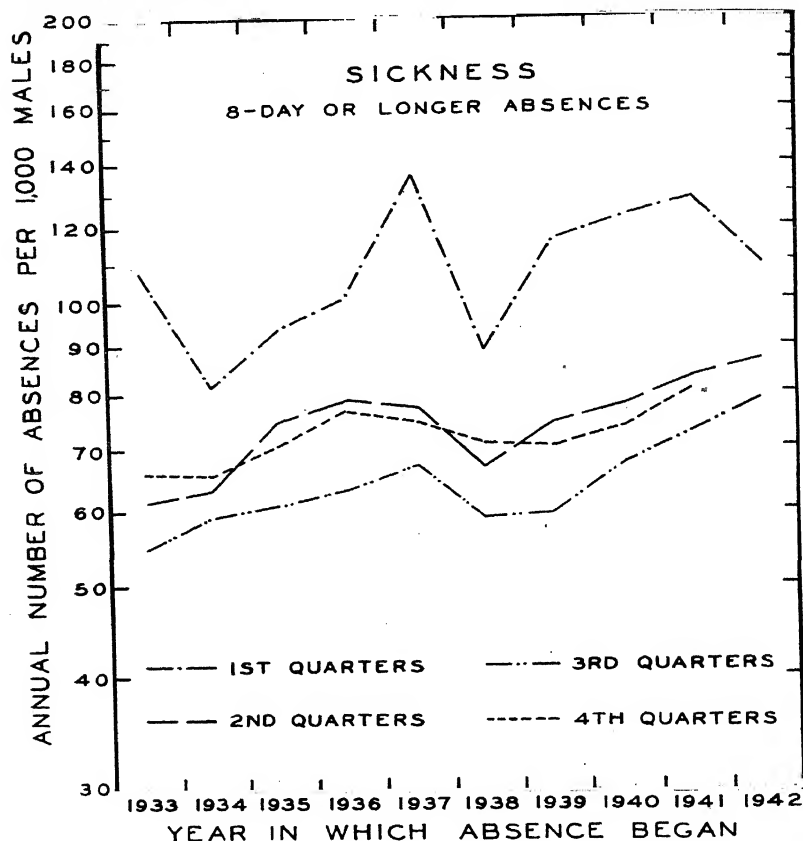


Fig. 9.—Average annual number of absences per 1,000 males from sickness disabling for eight calendar days or longer, variation of specific quarterly rates with time; experience of male employees in various industries, 1933–42, inclusive (logarithmic vertical scale).

cent report on a sample of glass workers it was found that the number of days of disability because of the rheumatic diseases

was over 50 per cent greater than the number accounted for by influenza and grippe.¹¹ Moreover, grinders, outside workers, and finishers experienced frequency, disability and severity rates well above the average for the entire group of workers.

Color

There is a notable paucity of published material on disabling sickness among comparable Negro and white populations. Appropriate data covering five years have been made available, the principal results of the analysis of which may be briefly summarized as follows:¹² As the occupations of Negro and white males became more nearly alike, the magnitude of the excess in the frequency rate of disabilities among Negroes tended to decrease, if not to disappear entirely. This suggested that it was differences in the type of work performed together with the associated socio-economic status rather than race *per se* which produced the unfavorable Negro health record when occupation was not held specific. Disregarding occupation, increasing age had the effect of reducing racial differences since the Negro rate showed a tendency to increase less rapidly than the rate for the white workers. The rates for respiratory and rheumatic diseases remained unfavorable for the Negroes and were less subject to the equalizing influence of occupation and age.

Duration of Disability

The number of absences of specific duration per 1,000 males and females, respectively, is shown in Table 2 for each of five broad cause groups.⁴ The data cover the four years, 1938-41, and represent over 10,000 male-years of exposure and almost 2,500 female-years. A comparison of the male frequencies with those of the females shows remarkable excesses for the latter in absences of 1, 2, and 3 days. Absences of these lengths due to the nonrespiratory-nondigestive diseases, when summed, occurred among the males at the rate of 71.5 per 1,000 males and among the females at 341.0 per 1,000 females or almost five times as often among the females as the males; the excess can be explained only partially by the presence of dysmenorrhea, since when all absences caused by this condition are disregarded (123.6 per 1,000 females from Table 1), the frequency among the females is still sufficiently large to be three times that among the males.

Table 2 also provides information on the contribution made by the absences of seven days' duration or less to the frequency

of absences of all durations. This information is of importance since most of the industrial sick benefit organizations making data available subscribe to a seven-day waiting period and thus, among other things, disabilities of seven days or less are not in

TABLE 2.—FREQUENCY OF ABSENCES LASTING ONE CALENDAR DAY OR LONGER DUE TO SICKNESS AND INJURIES, BY DURATION; EXPERIENCE IN A PUBLIC UTILITY, 1938-41, INC.

Duration of Absence in Calendar Days*	All Disabilities	Industrial Injuries	Nonindustrial Injuries	Sickness			
				Total	Respiratory Diseases	Digestive Diseases	Nonrespiratory-Nondigestive Diseases†
Annual Number of Absences per 1,000 Males							
All durations	919.7	22.4	42.8	854.5	541.7	153.7	159.1
1.....	222.8	2.7	9.0	211.1	120.7	58.4	32.0
2.....	133.3	1.1	3.8	128.4	85.3	23.4	19.7
3.....	147.3	1.5	4.8	141.0	96.8	24.4	19.8
4.....	85.8	1.4	3.4	81.0	57.9	11.0	12.1
5.....	60.5	0.5	2.4	57.6	41.9	7.4	8.3
6.....	56.0	1.3	2.4	52.3	39.2	4.2	8.9
7.....	60.0	1.1	4.0	54.9	39.4	4.7	10.8
8-14.....	65.7	3.4	6.3	56.0	38.1	4.7	13.2
15-28.....	33.0	2.1	2.9	28.0	12.7	3.7	11.6
29-49.....	24.2	2.7	1.7	19.8	5.3	5.5	9.0
50-98.....	20.6	3.1	1.7	15.8	3.0	5.5	7.3
99-139.....	6.3	1.2	0.4	4.7	0.7	0.6	3.4
140-371.....	2.3	0.1	...	2.2	0.4	0.1	1.7
372.....	1.9	0.2	...	1.7	0.3	0.1	1.3
Annual Number of Absences per 1,000 Females							
All durations	1,851.2	4.5	80.9	1,765.8	947.1	324.4	494.3
1.....	608.5	0.4	19.1	589.0	246.3	143.1	199.6
2.....	331.7	0.4	9.8	321.5	190.6	59.0	71.9
3.....	287.0	...	11.4	275.6	154.9	51.2	69.5
4.....	141.5	0.4	4.9	136.2	85.2	19.1	28.9
5.....	102.0	0.4	2.8	99.3	69.5	11.4	17.9
6.....	81.7	0.9	4.4	76.4	50.9	9.7	15.8
7.....	78.1	0.4	4.5	73.2	50.4	4.5	18.3
8-14.....	101.2	1.2	8.1	91.9	61.4	9.3	21.2
15-28.....	45.9	...	6.5	39.4	17.0	3.7	18.7
29-49.....	36.2	0.4	4.9	30.9	9.8	8.1	13.0
50-98.....	24.0	...	2.5	21.5	5.6	5.3	10.6
99-139.....	9.4	...	1.2	8.2	2.5	.....	5.7
140-371.....	2.4	...	...	2.4	.....	.....	2.4
372.....	1.6	...	0.8	0.8	.....	.....	0.8

* Number of calendar days from the date disability began to the date of return to work, or to the three hundred and seventy-second day, inclusive.

† Ill-defined and unknown causes included.

Number of person-years of exposure: males, 10,926; females, 2,460.

the records. A summation of the frequencies covering all disabilities for the first seven days is 765.7 for males, and 1630.5 for females. Thus for the males 83 per cent of the total frequency of 919.7 represent disabilities of seven days or less; for the females the corresponding percentage is 88 per cent.

Percentage Distribution, According to Broad Cause Groups, of Days Disabled on Specific Days of Disability after Onset

Disabilities of short duration are of importance particularly because of their relatively high frequency and because this group of disabilities is more likely to respond earlier than the disabilities of longer duration to any efforts toward prevention and control that may be initiated by the plant medical department. It is therefore appropriate to examine the percentage contributions made by the different broad cause groups to the total number of days disabled on specific days of disability after onset, say, through the 21st day.

Figure 10, based on data⁴ covering the four years, 1938-41, shows the various relations graphically. The pattern of the figure for each sex is determined by the duration and frequency of the various disabilities entering the five cause groups. Thus if all of the disabilities had lasted at least 21 days the resulting pattern would consist of five rectangles; if in addition identical frequencies had been yielded by the cause groups, the five rectangles would be of equal area. Actually the five areas fluctuate in size and shape as the specific day of disability after onset increases from 1 to 21. Contributions to the first day of disability after onset are made by all disabilities, namely, those lasting one day or longer; contributions to the second day are made by disabilities lasting two days or longer, the one-day disabilities dropping out; and similarly for the contributions to the remaining days of disability after onset.

Figure 10, therefore, shows graphically the effect of case duration on the distribution of causes. Of particular interest is the decreasing area representing the respiratory group, and the increasing area of the nonrespiratory-nondigestive group, as the specific day of disability after onset increases. These changing areas reflect, respectively, the relatively large number of respiratory disabilities of short duration and the relatively large number of nonrespiratory-nondigestive disabilities of long duration.

Further inspection of Figure 10 reveals that of the total number of first-days of disability among the males, 59 per cent were accounted for by the respiratory diseases, 17 per cent by the digestive diseases, 17 per cent by the nonrespiratory-nondigestive diseases, 5 per cent by nonindustrial injuries, and 2 per cent by industrial injuries.

Among the males the percentage for the respiratory diseases ranks first in magnitude on each of the first 10 days, the per-

centage rising from 59 on the first day to over 60 on the 2nd day and then gradually decreasing to 35 per cent on the 10th day. During this period the percentage for the nonrespiratory-nondigestive diseases gradually increases from 17 to 33 per cent, thus on the 10th day approximating the percentage for the res-

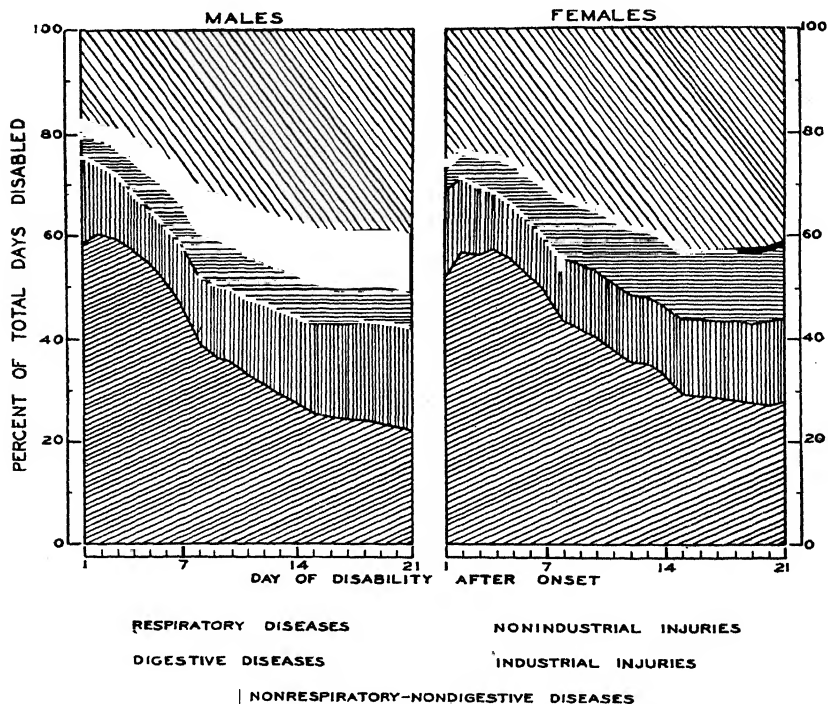


Fig. 10.—Percentage distribution according to broad cause groups of days of disability for a specified day of disability after onset; experience of male and female employees in a public utility, 1938-41, inclusive.

piratory diseases. On the 11th day and on each day thereafter the percentage for the nonrespiratory-nondigestive diseases is sufficiently large to assume first place among the percentages corresponding to the different cause groups. In the instance of the females the same phenomenon is evident not on the 11th day but on the 12th on which day the percentage for the respiratory

diseases has dropped to 36 and the percentage for the nonrespiratory-nondigestive diseases has increased to 39. The observable sex difference with respect to the nonrespiratory-nondigestive diseases during the first 2 days is probably accounted for, in part, by dysmenorrhea.

The percentages for the digestive diseases are of a lower order of magnitude beginning, among the males, at 17 per cent, falling to a minimum of 11 per cent on the 6th day, and gradually increasing to 20 per cent on the 21st day; the behavior of the percentages among the females is approximately similar to that of the males.

The percentages for nonindustrial injuries among the males fluctuate between 5 and 9 per cent, and among the females the corresponding range is 4 to 14 per cent. Among the males the percentages for industrial injuries gradually increase from 2 to 11 per cent while among the females they never become greater than 0.9 per cent during the first 21 days after onset of disability.

Days of Disability Contributed by Disabilities of Seven Days or Less

As a further contribution to the subject of short disabilities Figure 11 is presented. This figure is based on Figure 10 but only the first seven days of disability after onset are shown, and each of the cause group areas representing 100 per cent of the days of disability accounted for by a specific cause group during the first seven days of disability after onset is divided into two parts, the upper part representing the days from eight-day or longer disabilities and the lower part the days from the seven-day or less disabilities. Thus for all disabilities among the males, 83 per cent of all of the first days of disability after onset are accounted for by disabilities of seven days or less; moreover 68 per cent of all days determined by the first seven days of disability after onset are contributed by disabilities of seven days or less.

In a comparison of males with females all disabilities, respiratory diseases, and nonindustrial injuries, respectively, present similar pictures, while the remaining cause groups show for the females a larger proportion of days of disability contributed by the disabilities of seven days or less. With the exception of industrial injuries for the males all disease groups, regardless of sex, show a notable volume of days arising from the disabilities of shorter duration. It will be observed with reference to industrial injuries among the males that of all of the days accounted for

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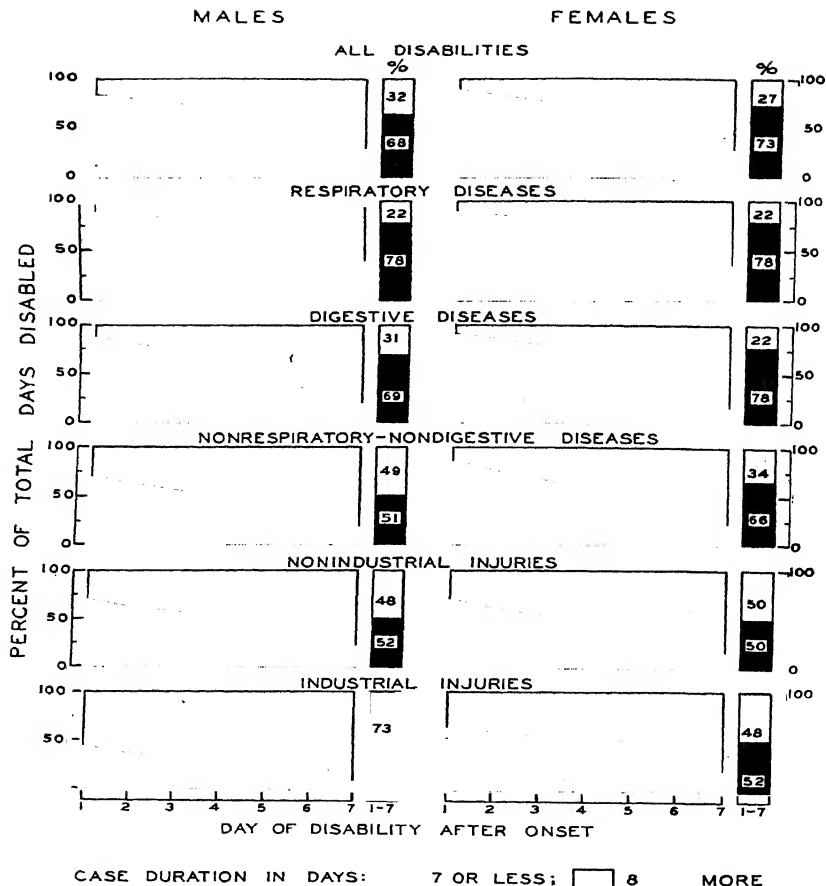


Fig. 11.—Percentage distribution, for each broad cause group of days of disability for a specified day of disability after onset, disabilities lasting less than eight days compared with those lasting eight days or longer; experience of male and female employees in a public utility, 1938-41, inclusive.

by the first seven days of disability after onset only 27 per cent are from disabilities lasting seven days or less. This indicates a preponderance of industrial injuries of eight days or longer.

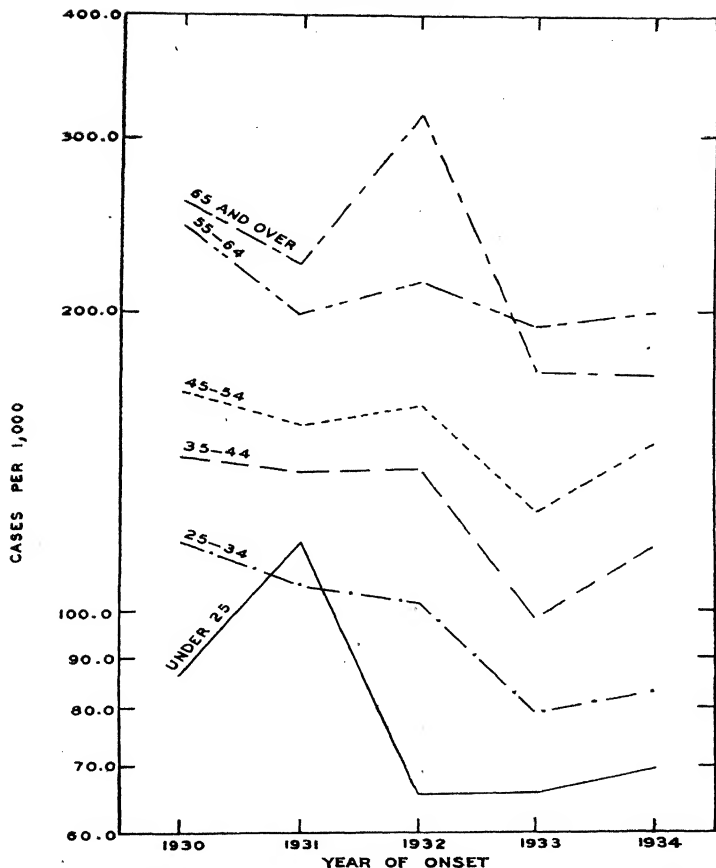


Fig. 12.—Average annual number of cases of disability per 1,000 males on account of sickness and nonindustrial injuries, cases lasting eight calendar days or longer, by age group and year of onset of disability; experience of white male members of the sick benefit organization of a railroad, 1930-34, inclusive (logarithmic vertical scale). The graph representing "all ages" is not shown; it follows closely the graph for ages 45-54.

Frequency and Duration of Sickness

It is appropriate to direct attention to the fact that as a measure of economic losses from sickness and injuries, the average

frequency rate may lead to erroneous conclusions, since this rate may decline while at the same time the average duration of disability may increase. Thus it was found among a group of approximately 30,000 white male industrial workers that while the average frequency of eight-day or longer disabilities followed a

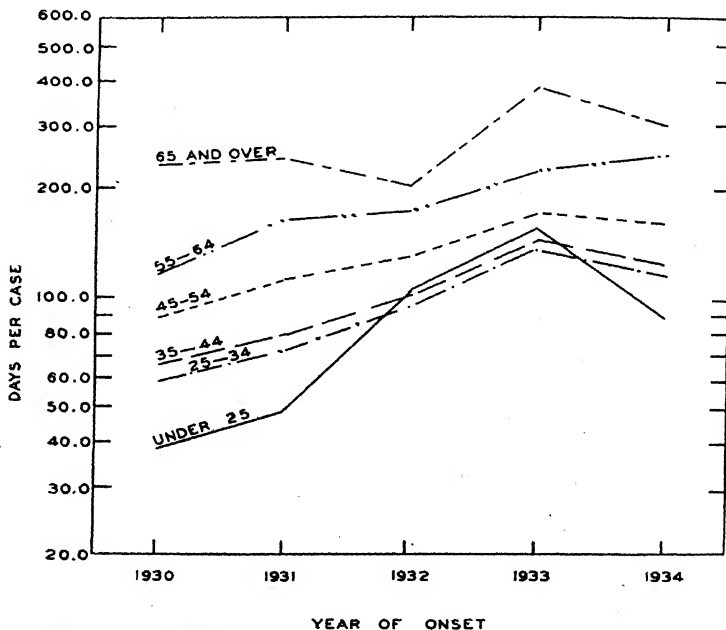


Fig. 13.—Average duration of cases of disability on account of sickness and nonindustrial injuries, cases lasting eight calendar days or longer, by age group and year of onset of disability; experience of white male members of the sick benefit organization of a railroad, 1930-34, inclusive (logarithmic vertical scale). The graph representing "all ages" is not shown; it follows closely the graph for ages 45-54.

downward trend during a five-year period, the average duration of disabilities moved upward.¹³ These observations are presented graphically by age group in Figures 12 and 13.

It will be seen in Figure 12 that while for each age group the frequency rates for successive years are not always less than

the corresponding rates for years immediately preceding, the time trends of the rates are generally downward. Attention is also directed to the upward trend in frequency with respect to age. This trend for a particular year may be seen in Figure 12 by reading vertically from age group to age group.

Figure 13 shows graphically the movement of the case durations with the passage of time for each of the six age groups. It will be observed that the rates for each age group follow an upward trend. When the age group under twenty-five years is disregarded it is seen that the graphs representing the time changes of the rates of the remaining five age groups appear in order of increasing age, indicating for each year an increasing duration of case with age. With regard to *rapidity* of increase in the time trends it will be observed that when the youngest and the oldest age groups are disregarded the rate of increase is approximately the same for each of the remaining four age groups; thus while the trends describe different paths, their rate of increase is approximately the same.

The insured wage-earning population of Scotland also shows an upward trend in case duration. In an attempt to account for this unfavorable trend the Medical Officer of the Department of Health for Scotland, refers to two factors: first, the aging of the population, and, second, the decline in mortality. According to this health official the aging of the population, when viewed in relation to the ages under consideration, offers only a small part of the explanation. With respect to the decline in mortality, he writes:¹⁴ "It is possible, indeed probable, that part of the increase is directly attributable to the saving or prolongation of life, death being postponed, but working capacity not necessarily restored. . . ."

Frequency Rates by Broad Cause and Age Groups for Absences Lasting t Days or More

Unlike a graph showing the frequency of absences of a specific duration, say t days, Figure 14 based on data on the male workers of an oil refining company¹⁵ presents the frequency of absences of t days or more for values of t from eight through 365 days. Each absence of t days in length contributes to one or more of the various frequencies for all sickness and nonindustrial injuries or a particular cause group, the number of the frequencies to which a contribution is made depending upon the duration of the absence. Thus the absence of eight days' duration contributes

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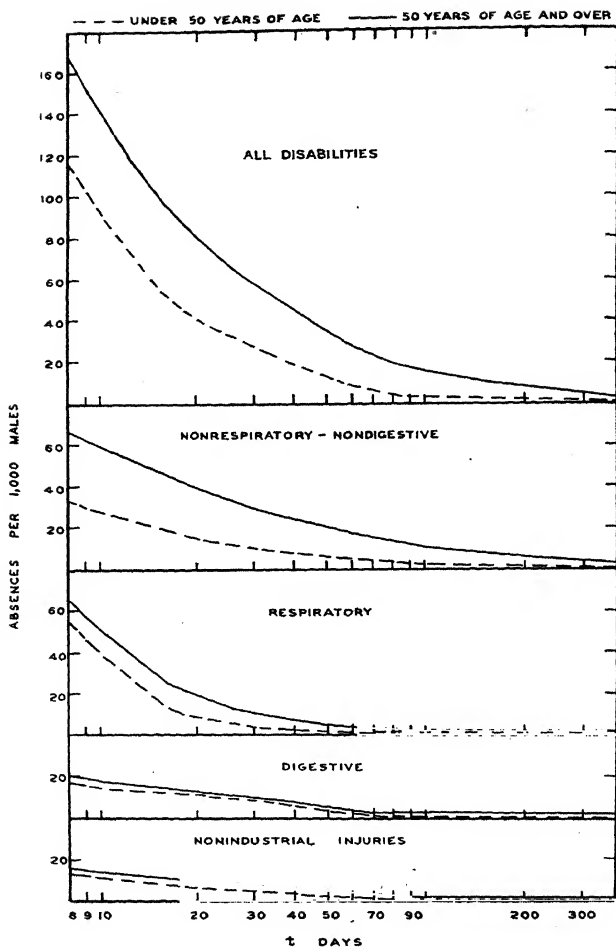


Fig. 14.—Average annual number of absences per 1,000 males from sickness and nonindustrial injuries disabling for a specified number of days, t or more, for ages under 50 and 50 and over; experience of male employees in an oil refining company, absences lasting eight calendar days or longer and ending during 1933-39, inclusive (logarithmic horizontal scale).

only to the frequency of eight-day or longer absences while an absence of 10 days' duration contributes to three frequencies, namely, the frequency of absences lasting eight days or longer, nine days or longer, and ten days or longer. In general as the t becomes larger the number of absences becomes smaller.

When a particular set of absence-durations is presented graphically with respect to the frequency of absences lasting t days or more for various values of t the initial plotted value will be determined by the total number of absences. This frequency, therefore, will be the maximum one and for this reason no curves of this type may have an upward slope. Should all of the absences be of the same length the graph of the frequencies would be a line parallel to the t axis. Should there be a relatively large number of long durations the graph would be a slowly decreasing curve; on the other hand a relatively large number of short absences would be reflected in a curve decreasing less slowly.

It is pertinent to state in this connection that in the event two sickness experiences show similar frequencies of disabilities regardless of duration, graphs such as those described would be particularly useful in showing pictorially any possible differences in the two experiences with respect to duration of disability.

It will be observed in Figure 14 that for all causes of disability and for each cause group, as t varies from eight through 365, the rate for male workers 50 years of age and over is consistently higher than the corresponding rate for males under 50 years of age. This difference in frequency is most marked for the nonrespiratory-nondigestive diseases and is least for the nonindustrial injuries and digestive diseases, respectively.

The most rapid decrease in rate for each age group is shown for the respiratory diseases where the initial frequency is approximately halved for the younger and older groups on the 13th and 14th days, respectively. Corresponding values for the other cause groups are: nonrespiratory-nondigestive diseases, the 19th and 26th days; nonindustrial injuries, the 22d day and fifth week; and digestive diseases, the fifth week and 28th day.

In comparing the frequencies of the two age groups it is of interest to note the value of t necessary in each cause group for the frequency among the workers 50 years of age and over to approximate the frequency of eight-day or more absences among the younger group. For all sickness and nonindustrial injuries the two frequencies would be approximately equal if absences of only 13 days' duration or more were included for the older males.

Corresponding values of t for nonindustrial injuries, digestive and respiratory diseases are 12, 11, and 9, respectively. For non-respiratory-nondigestive diseases, however, it would be necessary to have t equal to 27 or to include only absences lasting 27 days or more among the older group if the frequency rates for the two age groups are to be equal.

Disability Rates by Broad Cause and Age Groups from Absences Contributing t Days or Less

Instead of determining disability rates corresponding to absences of a specific length, say t days, the disability rate for a particular value of t may be determined by the sum of all t days or less that can be possibly contributed by all absences. Thus the average annual number of days lost per male when t is 8 is determined by contributions in days from all disabilities the size of each contribution being not more than eight days. When t is 9 the disability rate is larger since the 9th day of disability is contributed by all disabilities lasting more than eight days. It is evident that the disability rates when plotted against t can never be on a decreasing curve nor on a straight line parallel to the t axis. If absences were of the same length the disability rates when plotted on ordinary arithmetic graph paper would lie on a straight line with an upward slope. Thus if there were ten absences of the same length each successive t would add ten days to the number of days yielded by the t immediately preceding.

Figure 15 presents graphically the results of the application of the method described. The data on the male workers of an oil refining company are again used.¹⁵ Each cause group shows the rates for the older workers consistently higher than the corresponding rates for the younger workers.

The most marked difference in the rates with respect to age is shown by the nonrespiratory-nondigestive group of diseases, both age groups showing initial rates of less than one, and terminal rates greater than 1 and greater than 4, for the younger and older groups, respectively.

A pertinent question relating to the age factor is: What value of t for the older workers yields a disability rate approximately equal to the rate for the younger group with a t of 365 days? This particular disability rate is 3.3 days per male, a rate which corresponds among the older males to a t of about 4 weeks. Thus, the older group had accumulated during the first 4 weeks of disability a sufficient number of days of disability to yield a rate

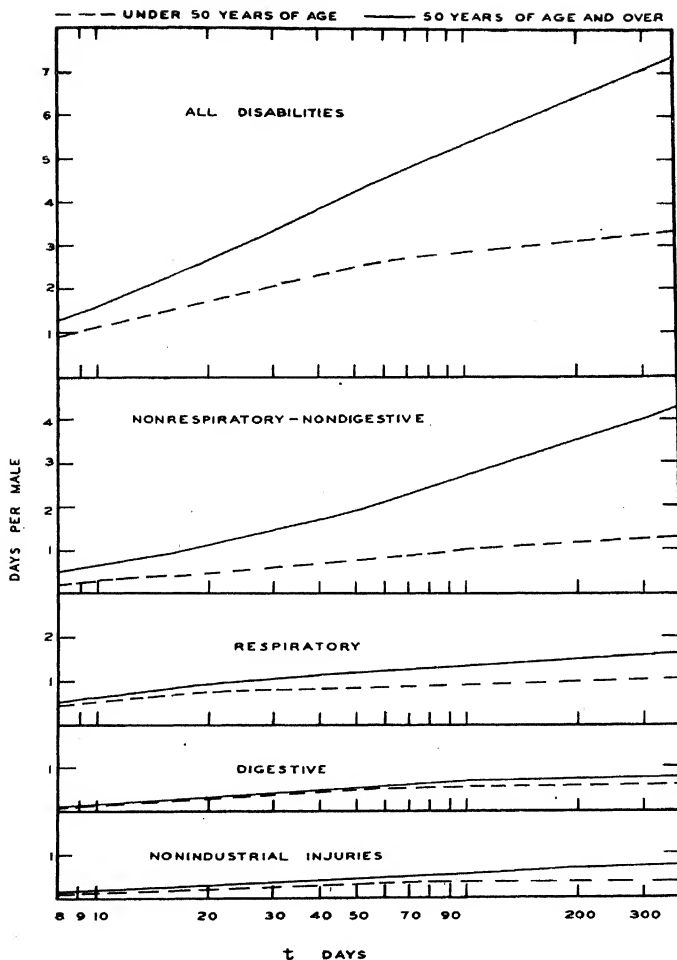


Fig. 15.—Average annual number of days of disability per male resulting from all disabilities contributing t days or less, for ages under 50 and 50 and over; experience of male employees in an oil refining company, absences lasting eight calendar days or longer due to sickness and nonindustrial injuries and ending during 1933-39, inclusive (logarithmic horizontal scale).

equal to that for the younger group based on a year's accumulation.

Nonrespiratory-Nondigestive Causes and Age

Reference is made to the noteworthy behavior, described in the two sections immediately preceding, of the frequency and disability indexes for the nonrespiratory-nondigestive group of

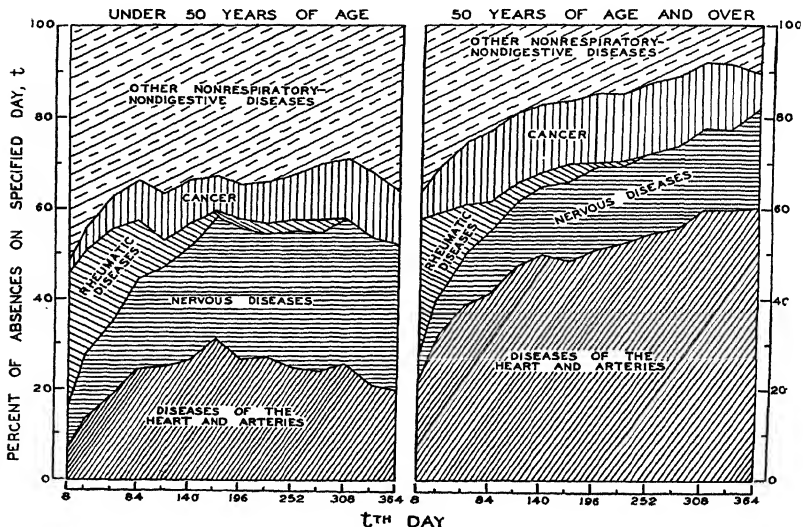


Fig. 16.—Percentage distribution according to cause of absences on account of nonrespiratory-nondigestive diseases for a specified day (t) of disability after onset for ages under 50 and 50 and over; experience of male employees in an oil refining company, absences lasting eight calendar days or longer and ending during 1933-39, inclusive.

causes when related to age. This raises the question of the contribution made by each of the causes defining this particular group of causes.

This question is answered graphically in Figure 16. The figure shows for each of two broad age groups the percentage distribution of absences (or days disabled) for specific days of disability after onset. Of interest is the magnitude of the contribution made by nervous diseases, and rheumatic diseases, respec-

tively, in the instance of the younger males, and diseases of the heart and arteries with reference to the older males. Of particular interest is the percentage distribution yielded by the 364th day after the onset of disability. On this particular day the younger group shows, among other things, that 20 per cent of the absences are accounted for by diseases of the heart and arteries while the corresponding percentage for the older males is 60 per cent. Notable also is the behavior of nervous diseases. Thus at about the 168th day and thereafter the percentage for this cause group among the younger males is over 25 per cent, the corresponding percentage for the older age group increasing approximately from 18 to 20 per cent.

Absences Lasting One Calendar Day or More: Frequency Rates by Broad Cause Groups

Published data on frequency and disability rates determined by absences of one calendar day or more are extremely scarce. It is purposed in this section and in the succeeding one to present for the male employees of a public utility company pertinent frequency and disability rates specific for three broad cause groups, and based on all ended cases that lasted one calendar day or more during the seven years, 1933-39.¹⁶

With regard to the age distribution of these workers the available information indicates that as of 1940 approximately 25 per cent were 50 years of age and over, a percentage that compares favorably with a number of other industrial populations studied by the Division of Industrial Hygiene.

The seven-year period represented by 18,487 male-years of exposure yielded 16,701 absences of one calendar day or longer, and 135,873 days of disability. When converted into average annual rates these data become 903.4 absences per 1,000 males and 7,350 days of disability per male.

The average annual number of absences per 1,000 males on account of sickness and nonindustrial injuries disabling for a specified number of days t or more is shown in Table 3, and graphically for the first 28 days in Figure 17. Thus the frequency of ended cases accounted for by the respiratory diseases and lasting two days or more is 432.7 per 1,000 males, while the corresponding frequency for the nonrespiratory diseases is 219.0. The magnitude of the rapidity of decrease of the frequencies with increasing values of t is determined by whether or not

there is a preponderance of long or short absences, the long absences inhibiting the rate of decrease while the short ones accelerate it.

TABLE 3.—ANNUAL NUMBER OF ABSENCES PER 1,000 MALES, ON ACCOUNT OF SICKNESS AND NONINDUSTRIAL INJURIES DISABLING FOR A SPECIFIED NUMBER OF DAYS t OR MORE, BY BROAD CAUSE GROUP, EXPERIENCE OF MALE EMPLOYEES IN A PUBLIC UTILITY, ABSENCES LASTING ONE CALENDAR DAY OR LONGER AND ENDING DURING 1933-39, INC.

t Days	Annual Number of Absences per 1,000 Males Lasting t Days or More				Number of Absences Lasting t Days or More			
	All Sick-ness and Nonin-dustrial Injuries	Nonin-dustrial Injuries	Respi-ratory Diseases	Nonres-piratory Diseases	All Sick-ness and Nonin-dustrial Injuries	Nonin-dustrial Injuries	Respi-ratory Diseases	Nonres-piratory Diseases
1.....	903.4	47.7	547.0	308.7	16,701	882	10,112	5,707
2.....	691.3	39.6	432.7	219.0	12,781	733	7,999	4,049
3.....	539.9	33.8	338.8	167.3	9,831	625	6,264	3,092
4.....	405.5	28.4	249.5	127.6	7,496	525	4,513	2,358
5.....	319.4	24.0	190.8	104.6	5,905	444	3,528	1,933
6.....	254.0	21.3	144.5	88.2	4,655	393	2,871	1,631
7.....	198.1	18.6	104.4	75.1	3,662	343	1,931	1,388
8.....	144.4	14.8	67.9	61.7	2,669	273	1,256	1,140
9.....	127.6	13.5	58.2	57.8	2,359	250	1,041	1,068
10.....	116.1	12.6	48.7	54.8	2,146	233	900	1,013
11.....	104.9	11.5	41.5	51.9	1,939	212	767	960
12.....	95.4	10.8	35.5	49.1	1,763	200	656	907
13.....	87.5	10.1	30.3	47.1	1,617	186	581	870
14.....	80.9	9.4	26.6	44.9	1,496	174	492	830
15.....	70.3	8.0	20.7	41.6	1,299	148	383	768
16.....	67.7	7.7	19.4	40.6	1,252	143	353	751
17.....	65.9	7.5	18.6	39.8	1,219	138	344	737
18.....	64.5	7.3	17.9	39.3	1,192	135	331	726
19.....	62.2	7.0	17.0	38.2	1,151	130	315	706
20.....	60.6	6.9	16.2	37.5	1,120	128	299	693
21.....	58.5	6.8	15.3	36.4	1,081	125	282	674
22.....	54.9	6.2	13.8	34.9	1,016	116	255	645
23.....	53.4	6.2	13.0	34.2	987	114	241	632
24.....	52.0	6.0	12.7	33.3	962	111	235	616
25.....	50.4	5.7	12.2	32.5	932	106	226	600
26.....	49.7	5.5	12.0	32.2	919	101	222	596
27.....	48.8	5.4	11.6	31.8	902	99	215	588
28.....	47.1	5.4	11.0	30.7	870	99	203	568
35.....	38.6	4.6	8.4	25.6	714	86	155	473
42.....	32.3	4.0	7.0	21.3	597	73	130	394
49.....	27.0	3.2	5.7	18.1	500	59	105	336
56.....	22.2	2.9	4.4	14.9	411	53	81	277
63.....	18.1	2.2	3.6	12.3	334	40	67	227
70.....	15.5	1.7	3.3	10.5	288	32	61	193
77.....	13.1	1.5	2.5	9.1	242	27	47	168
84.....	12.1	1.2	2.3	8.6	224	28	42	159
91.....	10.6	1.1	1.8	7.7	197	20	33	144
98.....	9.3	1.0	1.7	6.6	172	18	31	123
182.....	4.0	0.2	0.8	3.0	74	4	14	56
273.....	2.8	0.1	0.6	2.1	51	1	12	38
365.....	1.9	0.1	0.5	1.3	35	1	10	24
372.....	1.9	0.1	0.5	1.3	34	1	9	24

It will be observed that for each value of t the frequency for the respiratory diseases is consistently higher than that for the nonrespiratory diseases up through the eighth day; in the neighborhood of the eighth day, however, the two frequencies are equal

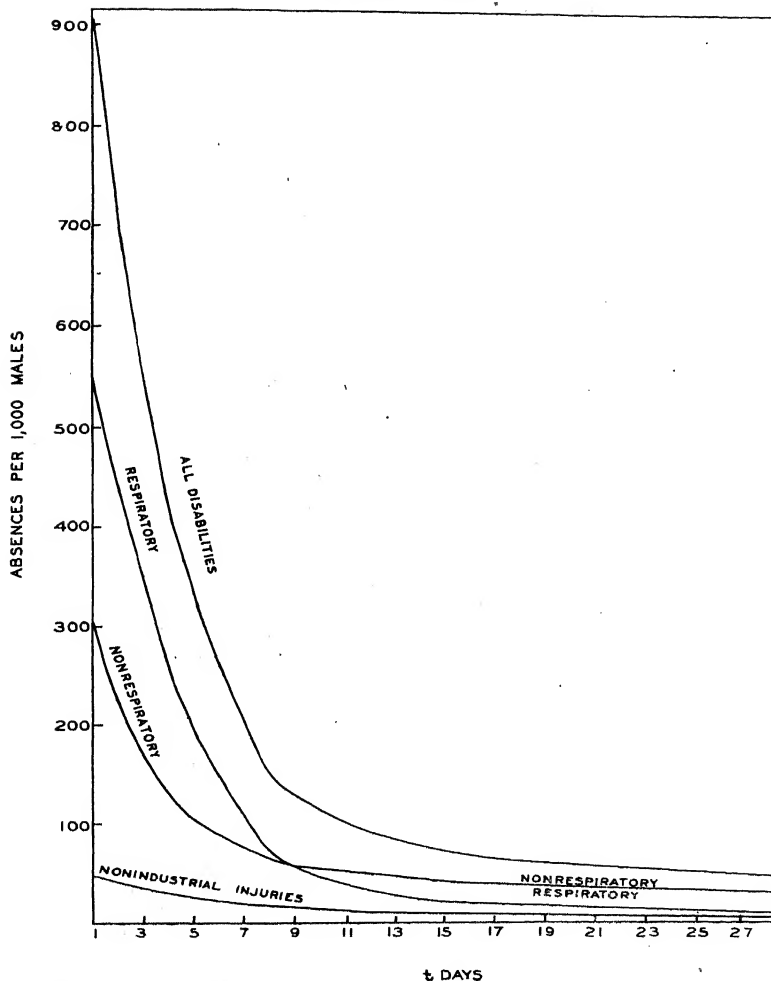


Fig. 17.—Average annual number of absences per 1,000 males on account of sickness and nonindustrial injuries disabling for a specified number of days, t or more, by broad cause group; experience of male employees in a public utility, absences lasting one calendar day or longer and ending during 1933-39, inclusive.

to each other, and for higher values of t the nonrespiratory frequencies are consistently higher.

Table 3 also permits the determination of the frequency of absences of any chosen duration. Thus the frequency of one-day absences is the difference between the frequency of absences lasting one day or more ($t = 1$) and the frequency of those lasting two days or more ($t = 2$), or 212.1 (903.4 minus 691.3).

Finally it is appropriate to add another interpretation of t in relation to frequency. Reference is made to the fact that t also represents the day of disability after onset on which a certain number of cases per 1,000 workers is still disabled or absent from work.

Absences Lasting One Calendar Day or More: Disability Rates by Broad Cause Groups

This section continues with further observations on the material¹⁶ introduced in the last section. The average annual number of days of disability per male resulting from all disabilities contributing t days or less is shown in Table 4. Thus for all sickness and nonindustrial injuries the average number of days per male per year varies from 0.9 to 7.350 as t assumes values from 1 through 372 days. It will be observed that the number of days (16,701) for t equals 1 is the same as the number of absences for t equals 1 shown in Table 3. Moreover the total number of days of disability (135,873) is given by t equals 372.

The rates are presented graphically in Figure 18. Most striking is the crossing of the curves for the respiratory and nonrespiratory diseases at approximately t equals 77. This phenomenon again reflects the relatively large number of short absences because of the respiratory diseases.

The Seven-Day Waiting Period

Since most of the benefit schemes making data available require that seven days elapse between the onset of disability and the commencement of the payment of benefits, such records contain no information on disabilities lasting seven days or less. The question is frequently asked, therefore, about the effect of the introduction of a seven-day waiting period on the frequency of, and time lost from, absences of all durations.

An opportunity to provide an answer to the question presented itself when the requisite data were made available by the record for the five years, 1933-37, of one-day absences or longer

that occurred among the employees of a public utility company, one that had been operating under a liberal disability plan for a quarter-century.¹⁷ The analysis of the data showed, among other

TABLE 4.—ANNUAL NUMBER OF DAYS OF DISABILITY PER MALE RESULTING FROM ALL DISABILITIES CONTRIBUTING $\frac{1}{2}$ DAYS OR LESS, BY BROAD CAUSE GROUP, EXPERIENCE OF MALE EMPLOYEES IN A PUBLIC UTILITY, ABSENCES LASTING ONE CALENDAR DAY OR LONGER DUE TO SICKNESS AND NONINDUSTRIAL INJURIES AND ENDING DURING 1933-39, INC.

1/2 Days	Annual Number of Days of Disability per Male Resulting from All Disabilities Contributing $\frac{1}{2}$ Days or Less				Number of Days of Disability Resulting from All Disabilities Contributing $\frac{1}{2}$ Days or Less			
	All Sickness and Nonindustrial Injuries	Nonindustrial Injuries	Respiratory Diseases	Nonrespiratory Diseases	All Sickness and Nonindustrial Injuries	Nonindustrial Injuries	Respiratory Diseases	Nonrespiratory Diseases
1.....	0.903	0.047	0.547	0.309	16,701	882	10,112	5,707
2.....	1.505	0.087	0.930	0.523	29,483	1,615	18,111	9,756
3.....	2.135	0.121	1.319	0.695	39,463	2,240	24,375	12,848
4.....	2.540	0.149	1.568	0.823	46,959	2,765	28,988	15,206
5.....	2.860	0.174	1.769	0.927	52,864	3,209	32,516	17,139
6.....	3.113	0.195	1.903	1.015	57,559	3,602	35,187	18,770
7.....	3.312	0.213	2.008	1.091	61,221	3,945	37,118	20,158
8.....	3.456	0.228	2.076	1.152	63,890	4,218	38,374	21,298
9.....	3.584	0.242	2.132	1.210	66,249	4,468	39,415	22,366
10.....	3.700	0.254	2.181	1.265	68,398	4,701	40,315	23,379
11.....	3.805	0.262	2.222	1.317	70,334	4,913	41,082	24,339
12.....	3.900	0.277	2.258	1.365	72,097	5,113	41,788	25,246
13.....	3.987	0.287	2.288	1.412	73,714	5,299	42,299	26,116
14.....	4.068	0.296	2.315	1.457	75,210	5,473	42,791	26,946
15.....	4.139	0.304	2.336	1.499	76,509	5,621	43,174	27,714
16.....	4.206	0.312	2.354	1.540	77,761	5,764	43,532	28,465
17.....	4.272	0.319	2.373	1.580	78,980	5,902	43,876	29,202
18.....	4.337	0.327	2.391	1.619	80,172	6,037	44,207	29,928
19.....	4.399	0.334	2.408	1.657	81,323	6,167	44,522	30,634
20.....	4.460	0.341	2.424	1.695	82,443	6,295	44,821	31,327
21.....	4.518	0.347	2.440	1.731	83,534	6,420	45,103	32,001
22.....	4.573	0.354	2.453	1.766	84,540	6,536	45,358	32,646
23.....	4.626	0.360	2.466	1.800	85,527	6,650	45,599	33,278
24.....	4.678	0.366	2.479	1.833	86,489	6,761	45,834	33,894
25.....	4.726	0.372	2.492	1.866	87,421	6,867	46,060	34,494
26.....	4.778	0.378	2.503	1.898	88,340	6,968	46,282	35,080
27.....	4.827	0.382	2.515	1.930	89,242	7,067	46,497	35,678
28.....	4.874	0.388	2.526	1.960	90,112	7,166	46,700	36,246
35.....	5.187	0.422	2.592	2.153	95,529	7,805	47,011	39,813
42.....	5.413	0.452	2.645	2.316	100,066	8,357	48,899	42,810
49.....	5.616	0.476	2.688	2.452	103,826	8,803	49,687	45,336
56.....	5.785	0.497	2.721	2.567	106,946	9,183	50,307	47,456
63.....	5.924	0.514	2.749	2.661	109,511	9,492	50,821	49,108
70.....	6.039	0.527	2.773	2.739	111,636	9,734	51,262	50,640
77.....	6.137	0.538	2.793	2.806	113,449	9,941	51,631	51,877
84.....	6.224	0.547	2.809	2.868	115,055	10,114	51,927	53,014
91.....	6.302	0.555	2.822	2.925	116,501	10,256	52,179	54,056
98.....	6.370	0.562	2.834	2.974	117,760	10,382	52,397	54,981
182.....	6.839	0.597	2.916	3.326	126,632	11,031	53,915	61,486
273.....	7.128	0.606	2.983	3.539	131,772	11,195	55,146	65,431
366.....	7.336	0.610	3.037	3.689	135,629	11,287	56,137	68,205
372.....	7.350	0.611	3.040	3.699	135,873	11,294	56,206	68,373

things, that although the males experienced annually 900 absences per 1000 males, and the females 1820 per 1000 females, only 153 absences among the males and 232 absences among the females extended through the eighth day; in other words, 17 per

cent of all recorded absences among the males extended through the eighth day while 13 per cent of all recorded absences among the females extended through the eighth day. Thus if the public utility were to operate under a seven-day waiting period the recorded absences among the males would be reduced by about 83 per cent while among the females the corresponding percentage

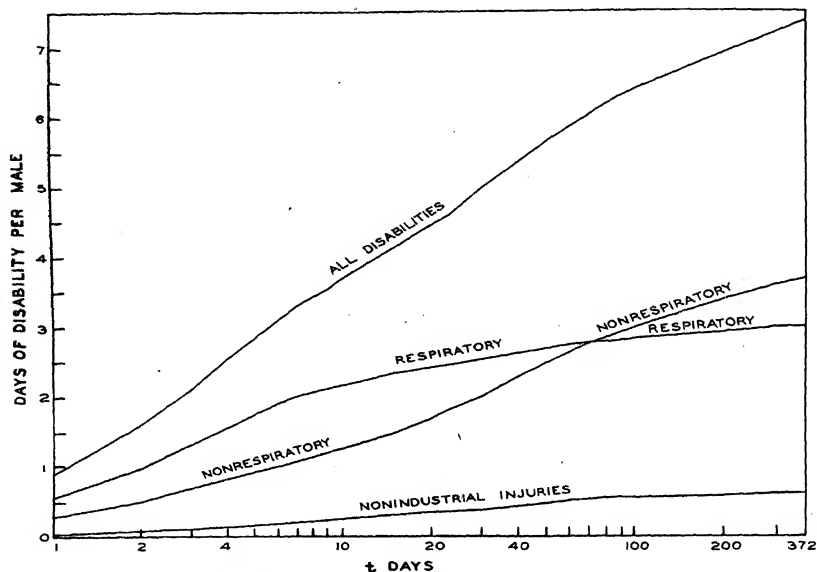


Fig. 18.—Average annual number of days of disability per male from all disabilities contributing t days or less, by broad cause group; experience of male employees in a public utility, absences lasting one calendar day or longer due to sickness and nonindustrial injuries and ending during 1933-39, inclusive (logarithmic horizontal scale).

reduction would be about 87 per cent. Furthermore, of the total recorded days of disability 45 per cent among the males, and 52 per cent among the females occurred during the first seven days of disability after onset.

It is appropriate to direct attention to the fact that Table 3 given in a preceding section may also be used so far as males are concerned, in determining the effect on frequency of the introduction of a waiting period of seven days. Indeed since the stub

of the table is in reality equivalent to a set of waiting periods the effect may be determined of the introduction of a waiting period of any chosen length. Let it be assumed that a waiting period of seven days is chosen. This means that absences of only eight days or longer are of interest. For $t = 8$ the frequency is 144.4; hence the frequency is reduced from 903.4 ($t = 1$) to 144.4 ($t = 8$) by the introduction of a waiting period of seven days. Figure 17 which is based on Table 3 shows graphically for the first 28 days how the frequencies decrease with increasing size of waiting period.

For the determination of the effect on the annual number of *days of disability* per male of the introduction of a waiting period of any chosen length Table 4 may be used. Thus the introduction of a seven-day waiting period discards all of the days accounting for the first seven days of disability after onset. In other words each eight-day or more disability contributes seven days to the discard while disabilities of less than eight days contribute all of their days. This reduction, for a seven-day waiting period, is 3.312 days per male annually which is the value given in the table for $t = 7$.

The Maximum Benefit Period

While the length of the maximum benefit period for which benefits are paid does not affect the frequency of recorded absences, it does influence those rates which depend upon time, since the days lost which extend beyond the termination of benefit payments are not in the records. An analysis¹⁸ of the records of some twenty-five benefit schemes showed, among other things, that the extension of a maximum benefit period of thirteen weeks to fifty-two weeks results in an increase of the average annual number of days disabled per male and per female of about 30 per cent and 23 per cent, respectively. An extension from twenty-six weeks to fifty-two weeks, on the other hand, results in an increase of the average annual number of days disabled per male and per female of about 13 per cent and 6 per cent, respectively. These calculations are based on *eight-day or longer disabilities* with benefit payments retroactive to the first day.

Calculations based on male disabilities of *one calendar day or longer* presented in Table 4 may be used to determine the effect on the disability rate of changing the length of a maximum benefit period since the stub of the table represents in fact a set of maximum benefit periods. Thus in extending the maximum bene-

fit period from 182 days ($t = 182$) to 365 days ($t = 365$) the annual number of days of disability per male is raised from 6.839 to 7.336, or an increase of 7 per cent. Figure 18 which is based on Table 4 shows how the disability rates increase with increasing length of maximum benefit period.

Per Cent of Workers Compensated

Another disability index of major importance is the per cent of workers compensated for a certain number of days or more on account of sickness and nonindustrial injuries. For purposes of illustration there is available⁴ the experience of 18,000 workers of a railroad who were members of the sick benefit organization from 49 through 60 months during the five years, 1930-34. There is a waiting period of seven days and continuous benefits are allowed.

Table 5 shows the requisite data by age group. It will be observed that the oldest age group presents the highest percentages for each value of t , approximately 50 per cent of the members of this age group being compensated during the five years for one or more days, and 4 per cent for 1,461 days or more. The percentages for each age group gradually decrease with increasing values of t , the percentages for the different age groups for a specific value of t generally decreasing with decreasing age.

Additional pertinent material is provided in further references.¹⁹⁻²¹

Other Factors

There are many other factors which are of importance in their relation to disabling sickness, particularly those introduced by the emergency. Thus it was recently stated that the lowest absenteeism rates were found in plants where promotion is possible for efficient workers, and where there is stability but not rigidity of organization.²² Adverse factors undoubtedly frequently include emotional strains effected by the nagging of a person in charge, the absence of reasonable consideration, a lack of authority over assistants, and personal mental conflicts.^{23, 24}

It is appropriate to recall three factors that were emphasized in the reports and memoranda of the British Health of Munition Workers' Committee issued during and after the first World War.²⁵ Reference is made to *large increases of workers, overtime* with its attendant fatigue, and *night work*. In this connection it

was found that increases in the force of iron and steel workers were associated with increases in the frequency of pneumonia.²⁶

The factors referred to have to do with the plant environment and the worker himself. A considerable number of factors related

TABLE 5.—PER CENT OF WORKERS COMPENSATED FOR *t* DAYS OR MORE BY AGE GROUP; EXPERIENCE OF WHITE MALE WORKERS OF A RAILROAD WHO WERE MEMBERS OF THE SICK BENEFIT ORGANIZATION FROM 49 THROUGH 60 MONTHS DURING 1930-34, INC.

<i>t</i> Days	All Known Ages	Under 25	25-34	35-44	45-54	55 and Over
Per Cent of Workers Compensated for <i>t</i> Days or More						
1.....	40.3	31.8	30.5	36.5	42.2	50.9
20.....	25.8	18.2	16.3	21.4	26.9	38.3
183.....	8.5	2.5	3.6	5.6	8.5	16.9
366.....	5.8	1.5	2.3	3.6	5.4	12.4
548.....	4.6	1.5	2.0	2.7	4.4	9.9
731.....	3.8	1.5	1.6	2.4	3.7	7.9
913.....	3.3	1.5	1.5	2.0	3.3	6.6
1096.....	2.7	1.0	1.2	1.7	2.8	5.3
1278.....	2.3	1.0	1.1	1.4	2.4	4.6
1461.....	2.0	1.0	0.9	1.2	2.1	4.0
Number of Workers Compensated for <i>t</i> Days or More						
1.....	7,309	63	808	2,124	2,432	1,882
20.....	4,683	36	432	1,247	1,552	1,416
183.....	1,541	5	96	327	489	624
366.....	1,044	3	62	207	314	453
548.....	833	3	54	158	252	366
731.....	687	3	41	137	214	292
913.....	594	3	39	115	193	244
1096.....	491	2	33	98	162	196
1278.....	424	2	30	81	140	171
1461.....	364	2	24	69	122	147
Number of members....	18,135	198	2,645	5,826	5,765	3,701

Note: The number of days for which a worker is compensated is the summation of all of his case durations yielded by the five-year period; because of the waiting period, however, seven days have been subtracted from each case duration.

to disabling sickness concerns the environment outside of the plant, for example, housing shortage, living conditions, transportation facilities, nutrition, availability of prompt and efficient medical service, and community sanitary conditions.

PERSONAL REASONS*

The increasing absenteeism for personal reasons is seriously engaging the attention of those directly and indirectly responsible for uninterrupted industrial production. This type of absenteeism frequently appears in the records as disabling sickness. Included among personal reasons are those related to transportation facilities, and weather; sickness or death in family or among associates; home conditions, marketing, shopping, household responsibilities, and moving; overcelebration, holidays, vacations, and hunting; and paying taxes, voting, the operations of Selective Service, and jury duty.

Operating also is a host of psychological reactions of the individual worker giving rise to some of the reasons already mentioned and including among others the lack of interest in a higher income effected by the decreasing availability of consumers' goods, or by the desire to reduce the amount of income taxes that would otherwise be payable.

The psychological reactions are determined primarily by the general work situation, and by the prevailing social and economic conditions.²⁷ Of prime importance is the effect of such conditions upon the life of the worker. The *general work situation* is determined by placement of workers, management policy and attitude, and physical working conditions. The *prevailing social and economic* conditions include factors necessitating a change in the normal patterns of living effected, for example, by the change from the previously generally accepted five-day week to six or seven days of continuous work; by the introduction of shifts and their rotation; the lack of recreational opportunities; inadequate or overcrowded housing conditions; insufficient transportation facilities; and a rapidly expanding industrial organization.

Of interest in connection with absences from all reasons is a one month's absenteeism experience of an ordnance plant.⁴ The number of one-day or longer absences per 1,000 males (annual basis) was approximately 3,500 of which less than one-third was accounted for by disabling sickness and injuries, and about one-sixth by reasons connected with transportation. The frequency of absences lasting one day was almost 2,500 per 1,000 males of which over 1,700 per 1,000 were attributable to causes other than

* Other reasons for absenteeism which are not discussed in this chapter may be grouped under two main heads: (1) *Disciplinary Reasons* including Carelessness, Poor Work, Violation of Rules, and Other; and (2) *Work Not Available* including Inventory, Lack of Business, Machine Breakdown, and Other.

sickness. Moreover of the 7.6 days lost per worker (annual basis) over one-half was accounted for by reasons other than sickness.

Another experience⁴ covers a group of metal miners for the year 1940. The frequency of one-day or longer absences from all reasons was over 5,000 per 1,000 miners, reasons other than personal sickness and injuries accounting for almost 2,000 absences per 1,000. Of the 26 days absent per miner per year 6 days were attributable to reasons other than personal sickness and injuries.

CONTROL OF ABSENTEEISM

Records

Obviously the first essential in a program of control of absenteeism is the determination of where, when, and under what conditions the absenteeism is occurring. A few plants will find it impracticable at the outset to collect data on absences of all durations and from all reasons. A decision must be made with regard to length of absence and whether absences of a specific length or longer shall include those from all reasons. As a *minimum* it is recommended that data on absences lasting 8 consecutive calendar days or longer be collected and that the reasons for absence be confined to sickness and nonindustrial injuries. While data on these more or less serious disabilities are being collected and analyzed consideration should be given to expanding the coverage to include absences of shorter duration and from all reasons.

Regardless of the length of the absence and the reason for it data on the following items should be collected on each absence and be considered as a *minimum*:

1. Color.
2. Sex.
3. Date absence began.
4. Date absence terminated.
5. How absence was terminated. (Returned to work, Died, Resigned, Separated, Permanent disability, Other.)
6. Reason for absence. (Sickness, Nonindustrial injury, Industrial sickness, Industrial injury,* Other.)
7. Diagnosis.
8. By whom the diagnosis was made.

In addition to these items it is necessary for the calculation of rates to know the *number of workers* in the plant by color, and sex. Many of the tables and graphs presented in this chapter are based on information covering the items as listed above, and

* No further reference will be made to *Industrial injury*. The reader is referred to Kossoris²⁸ in the list of references.

Fig. 20.—This form, Number 2, applying to absences on account of sickness or nonindustrial injury among the group of workers under observation, is designed to carry information on those absences which may have begun at any time and have not as yet terminated. The absences are, therefore, those whose records are carried over into the month following the current reporting month (size: 10.5 inches long by 8 inches wide).

age, to know the *number of workers* in each department or occupation by age. Furthermore to determine the worker who is repeatedly absent it is necessary to have his Social Security Number or other identifying symbol.

Reliability of Rates

Finally it must be recognized that while theoretically a rate can be made specific for department, occupation, age, sex, color, and for whatever reason, the rate will be of questionable value if the number of workers in the plant is small. Thus the number of workers in the group "exposed to risk" will determine principally the number of subgroups that may be profitably analyzed.

Analysis of Data

The periodic analysis of the records will point to conditions requiring attention, and to appropriate methods of control; in some instances a *study* will be indicated which will require the collection of additional pertinent data.

Sickness

The sick absences generally responding most readily to control efforts are the minor maladies in which temperament, anxiety, lack of a sense of responsibility, maladjustment and physical ill health meet and influence each other; the proper routine supervision of sick absences should give the plant physician the opportunity of suggesting an appropriate remedy.^{24, 31}

It is possible for the first-line supervisor to be of considerable assistance in the control of sick absenteeism. Thus he may note not only unhealthful working conditions but what is of comparable importance possible precursors of disabling sickness which manifest themselves in the worker as visible signs of ailments, or in the worker's decreased productivity.

Personal Reasons

The absences because of personal reasons are probably most subject to control and it is perhaps with these absences that the worker's psychological reactions are most closely related; here the importance of the first-line supervisor can hardly be overestimated for he is in an excellent position to influence the attitudes of his workers.²⁷

Strong *moral persuasion* exerted by campaign posters, literature, and talks by management appealing to patriotism and common sense have been fairly effective in holding men on their jobs. Absenteeism has been reduced in some instances by pressure from labor leaders who reason that unnecessary absence from war work constitutes an offense against coworkers. Shopping time has been reduced by some plants by establishing food stores, barber shops, and other facilities on the plant premises; other

plants have succeeded in obtaining a different schedule of store hours.^{32, 33}

In some plants in England successful appeals have been made to the *patriotism and generosity* of the workers; in others the workers have been asked to suggest weekly slogans stressing the national importance of the work and the need for regular attendance; and in some plants competition among shifts has been found of value.³⁴

A California shipbuilding organization as a part of its program for the control of absenteeism launched a "slave" ship to warn absentees.³⁵ The vessel was named the *S. S. Absentee*, and the laying of the "keel," a long, black piece of plywood, was performed under the guidance of "Mr. Lost Man-Hours," president of the "Absentee Workers' Association." Speeches by three workers impersonating the Axis leaders indicated in factual terms the gains enjoyed by the Axis as a result of the time lost by the absentees. According to the news report the workers were amused at first but returned to their jobs "thoughtfully and unsmiling."

Kushnick²⁷ stresses the importance of *morale* in the psychological factors connected with absenteeism and pertinently summarizes the situation as follows:

"It seems to me that the solution to the problem of reducing avoidable absenteeism lies in finding ways of stimulating the inclination to work. To do so constructively means an acceptance by management of the maxim that the worker is impelled by an inner urge to find an environment where he can take root; where he gets a sense of belonging; where he has a real function; [and] where he sees the purpose of his work and feels important in doing it."

Investigation of Absences

If workers know that their absences are unnoticed many of them are likely to consider absenteeism lightly.

The Metropolitan Life Insurance Company³⁶ reports in this connection, as follows: (1) when workers are *sick* many large organizations offer the services of a company nurse who makes a friendly visit to render whatever assistance is possible and reports on the probable duration of absence and the need for further assistance; (2) when the reason for absence is *unknown* some companies depend upon the department head to investigate, and others send a representative of the personnel department, telephone the absentee's home, or send a form letter with

a return postal card enclosed requesting information; (3) when workers return to work *after sickness* they often are required to bring a physician's certificate, or report to the company medical department, or both; and (4) when workers return to work who *have not been ill* and whose absences *have not been excused* in advance, they are often required to report to the personnel department or their own department head for an interview.

Excellent results have been reported⁸⁷ in the control of absenteeism among the 200 workers of a foundry. The nurse visits the worker's home to ascertain the cause of absence. If the cause is sickness she may decide on its seriousness; other reasons for absence "are tactfully handled."

SUMMARY AND CONCLUSION

Sufficient evidence has been presented to indicate the magnitude and nature of the problem of absenteeism among industrial workers, a problem that is seriously affecting industrial production. The measurement of absenteeism was examined. The comparability of rates was discussed. Some of the factors related to absenteeism were reviewed and the interrelation of a number of these factors was observed. Reference was made to the control of absenteeism.

For the formulation of an effective program of prevention and control the pertinent data should be uniformly recorded, carefully analyzed, and interpreted with caution.

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